for . . .

engineers and contractors controlling the design, specification, installation and maintenance of heating, ventilating and air conditioning.

HEATING AND VENTILATING

The Air Conditioning Monthly

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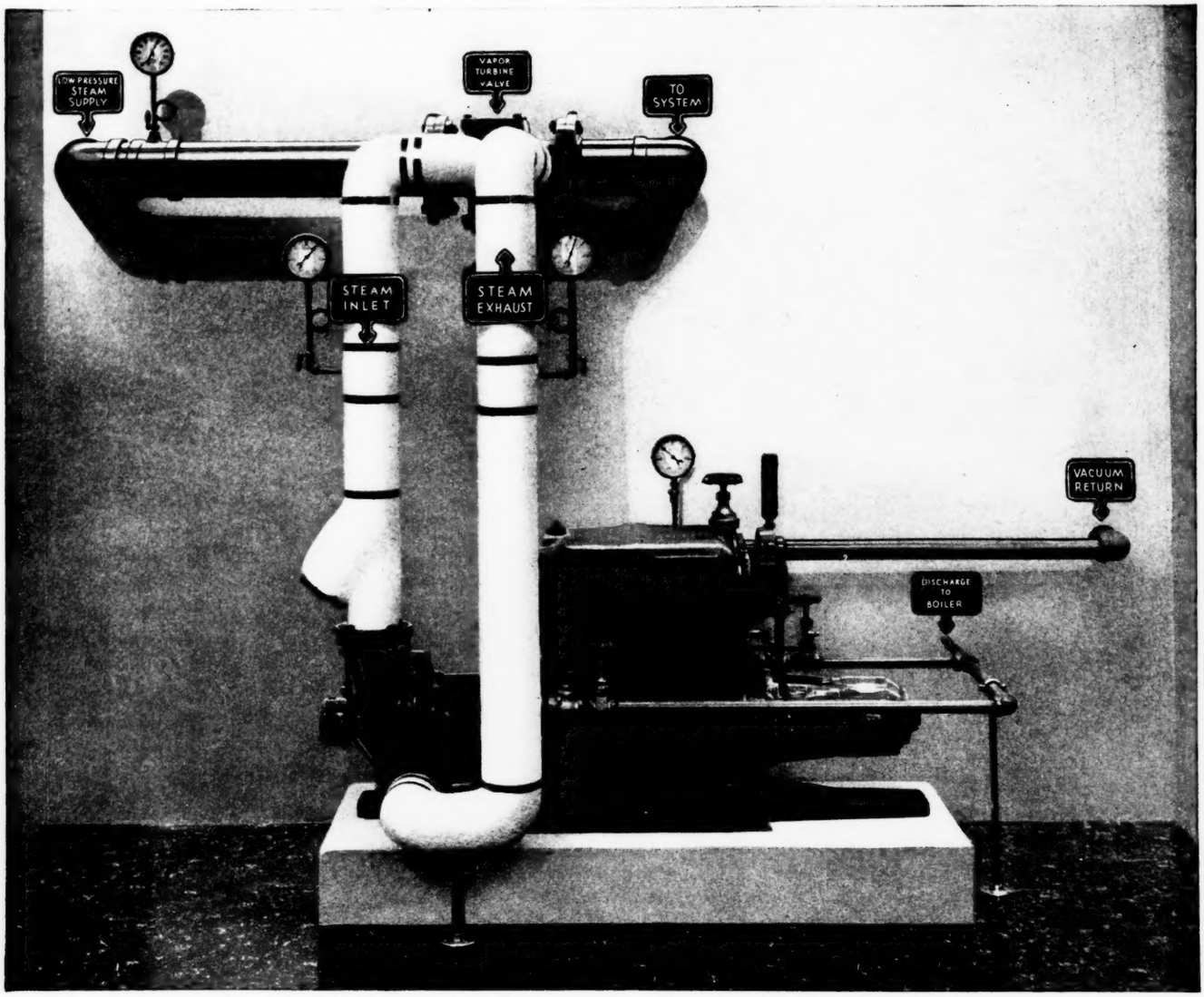
Where Heat Must Not Fail— Install this SAFE Heating Pump!



In Hospitals, Greenhouses, Schools, Public Buildings, Theatres, wherever heating systems must not fail, install the Nash Vapor Turbine, for it is independent of electric current failure, and continues to operate as long as there is steam in the system.

This is because the prime motive power of this economical pump is a special steam turbine, controlled by a unique "Vapor Turbine Valve", which automatically bypasses from the heating main a small portion of steam, the exact amount necessary to develop the power needed to remove the condensate and maintain the required vacuum on the system. Even this small amount is passed immediately back to the mains, and goes on to the system with little heat loss. This pump operates on any system, high or low pressure.

The Vapor Turbine is a most economical pump, for the elimination of electric current does away with current cost, the largest single item in the operation of an ordinary return line heating pump. Bulletin on request.

THE NASH ENGINEERING COMPANY
205-A S. WILSON ROAD, SOUTH NORWALK, CONNECTICUT, U. S. A.

Carl Baehr describes an outstanding example of

Modern Hospital Practice

in heating and ventilating, as carried out in the Delaware Hospital, Wilmington, Del., where the author is chief engineer

FIFTY-FOUR years ago a group of civic minded individuals in Wilmington, Del., worked together collecting funds to open a hospital. The location of 14th & Washington Sts., overlooking Brandywine Creek, was chosen, and on February 20, 1890, the formal dedication was held. At that time there were but ten physicians on the staff, and only 161 patients received treatment during the first year. Fifty years later, in 1940, more than 28 times that many patients received medical and surgical care at this institution.

In the early days of the hospital the boiler plant was very meager. There was an eighty horsepower H.R.T. boiler fired with a shovel and the sweat of man power In the years following, the hospital grew and the boiler plant later consisted of two stoker-fired 150 hp Edge-Moor water tube boilers.

As Wilmington grew, it was also necessary for the hospital to expand in order adequately to serve the needs of that city and surrounding territory. This latest and largest hospital expansion was made possible through the kindness of a few people in Wilmington who prefer to remain anonymous. Massena and duPont, Wilmington architectural firm, prepared plans for the building design which resulted in the beautiful U-shaped building now approaching completion. The plans for the necessary steam plant expansion were prepared by the consulting engineering firm of Jaros, Baum and Bolles, New York.

The resultant boiler plant leaves little to be desired as to modern equipment. Nothing was overlooked to provide for high efficiency. A modern heating system automatically controlled keeps the patients comfortable at all times. As one walks to various parts of the hospital such as the laundry, or the kitchen, there is something unique to attract the eye. One item of particular interest is the modern pneumatic conveyor system, installed by Benjamin F. Shaw Co., by which messages, diet lists and doctor's instructions can be rapidly conveyed to their proper destination.

Boiler Plant

The steam plant now consists of three 300 hp Edge-Moor boilers. Each boiler is fired by two automatically-controlled Johnson oil burners, to operate at 500 hp capacity. Reliance high and low alarm safety water columns provide continuous check of boiler water levels.

The boiler room panel gives complete information as to efficiency. Each boiler is equipped with a Hays pointer draft gauge and CO_2 recorder and indicator, and a Cochrane indicating, recording and integrating steam flow meter. The feed water flow to each boiler is measured by a Cochrane electric flow meter. There

A typical private room in the Delaware Hospital. Piping to the radiators is furred in the wall.

are auxiliary records on the charts for flue gas temperature, feed water temperature and steam pressure.

The readings of oil meters and water flow meters constitute a complete record of the evaporation of water into steam per pound of fuel. The operating engineer can tell at a glance the efficiency of combustion at all times. The CO_2 recorder gives him a complete check on this twenty-four hours a day. This is a vast improvement over the old boiler room where the engineer had nothing but a steam pressure gauge and a water column to guide his operation.

From his office overlooking the boiler room, the chief engineer can sit at his desk and, with a glance to his right, see the main distribution meter panels, which are equipped with hooded lights for ease of reading. All instruments are properly arranged as to their service. All steam equipment is on the left panel and all water equipment is on the right panel. On the steam panel, Ashton pressure gauges indicate the pressure of the high pressure, medium pressure, and low pressure steam, as well as the pressures of the steam to the laundry and kitchen.

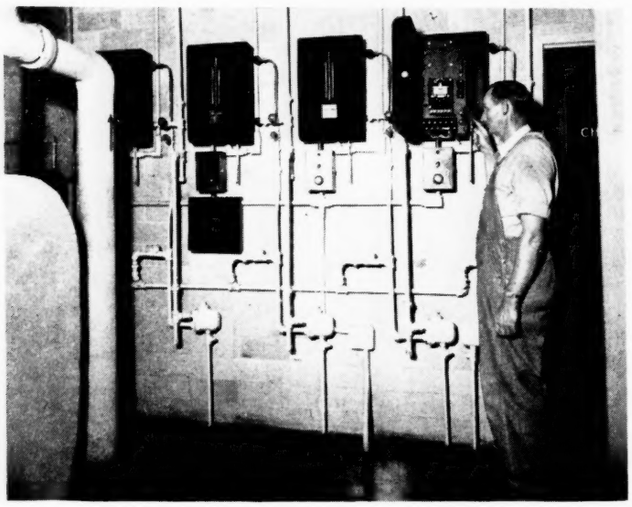
Directly below the pressure indicators there are centralized, for the convenience of the engineer, complete records of steam flow and steam pressures and temperatures on the meters. Orifice plates and flow transmitters are located at the most convenient piping location and wired from the transmitter to the panel. All the recording meters are accessible from the front of the panel, the meters being hinged for that purpose, thus eliminating going behind the panel for checking.

Use of Data

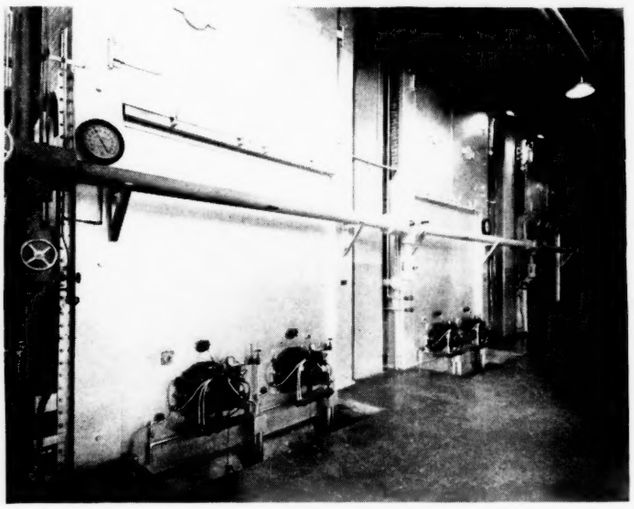
With a record as to the steam flow, pressure and temperature of the various distribution lines, complete steam costs can be properly computed. Should there be at some future time an excessive amount of steam consumed in the laundry, for instance, there would be no need for this loss to go on unnoticed, because the Cochrane flow meter on the line is standing guard over these costs. With this method of allocating costs, the boiler room is not charged as an overhead, but rather as a producer, and each department is accurately charged with its share of the cost of steam consumed.

As the complete steam costs are determined, so are the water costs. There are Cochrane temperature recorders on hot water generators and a temperature indicator for the water entering the building. A six-inch venturi tube in conjunction with the electric flow meter, measures the complete amount of the water entering the building. Flow measurement is also made of the hot and cold water to the laundry, the kitchen and the water service.

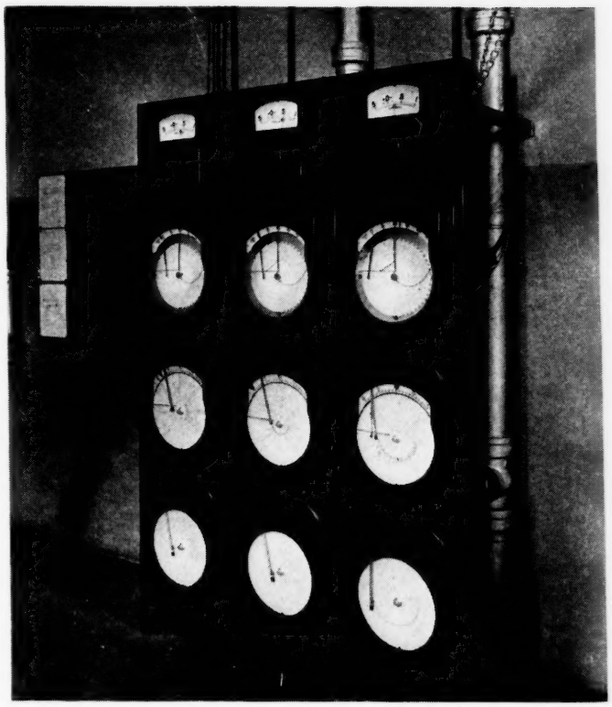
Venturi tubes were used for the primary element in the measurement of water in order to obtain a higher degree of accuracy over a wide range of flow. Temperature and pressure records of the water are also made. This gives again the complete cost picture for water, as is given for steam costs. All these meters are located in the office of the engineer and each instrument is marked as to its service. The recording meters each have a black bakelite nameplate with etched white letters to indicate their service, such as "Laundry Steam."



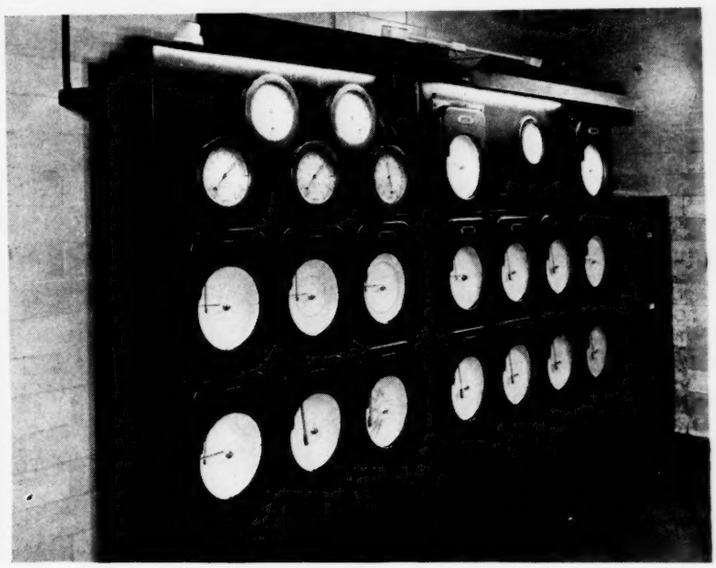
Moderator controls and connections, located immediately outside the chief engineer's office.



Front of the boilers in the Delaware Hospital showing the three 300 hp oil burning units.



(Left) Boiler room panel gives full information as to performance of each of the three boilers. (Below) Distribution panel in chief engineer's office contains Ashton pressure gauges for high, medium, and low pressure steam, as well as kitchen and laundry steam. Flow meters measure flow of steam and hot and cold water to kitchen, laundry, and for other uses.



Heat Distribution

The heating system is a Webster Moderator system, with six zones. The operating room floor, however, is an exception as this is an entirely independent system of piping and is uncontrolled. The automatic zone control varies the quantity of steam supplied to each radiator in accordance with the outdoor temperature; it is also capable of manual variation of the steam so supplied independent of the outdoor temperature and of any other zone.

The heating system operates as follows: Let us assume that the thermostat is at 70F. Then the control set will operate at zero position (no steam pressure) and the circuit will be balanced. Now let us assume that the outdoor temperature changes to 60F. The movable arm in the thermostat (located on the roof, one for each two zones) will slide over the resistor and add resistance to the circuit. This unbalancing of the circuit causes the relay to become unbalanced and in turn the main steam control valve will open. When the main valve opens, the steam pressure is increased in the heating system. This pressure is transmitted to the mercury column which causes it to rise and cut out resistance from the resistor in a transparent tube. When the amount of the resistance cut out by the mercury equals the amount of resistance cut in on the thermostat the relay will become balanced and the motor on the main steam control valve will stop.

The variator is introduced into the circuits across the coil of the relay so that the resistance values of these circuits can be manually changed. The changing of these values results in an increase or decrease of the resultant steam pressures.

The installed radiator surface totals as follows: Unit 1, 17,695 sq ft; Unit 2, 14,045 sq ft; Unit 3, 8,500 sq ft.

Unit ventilators are installed in addition to the direct radiation in the Nurses' Dining Room and the Delivery Rooms. These units are of the Syncretizer type and have sufficient capacity to heat only the air from 0F outside temperature to approximately 70F delivery temperature. Air circulation and distribution are such that only 2F maximum variation in room temperature is permitted during occupancy throughout the heating season.

The five operating rooms are air-conditioned by Carrier. There are also small air-conditioning units which may be plugged in private rooms upon special request. Due to an exceptionally well designed system of exhaust fans, the total capacity of which is 181,000 cfm, there is an absence of the usual hospital odors.

When the hospital extension program is finished, it will be not only one of the oldest, but one of the most modern and largest hospitals in the State of Delaware. From the twenty beds and ten physicians in 1890, the institution has risen to its completed size of about 350 beds and 55 bassinets, with a staff of approximately 120.

Those responsible for the expansion, made in three units, include: C. A. Hume, Hospital Superintendent; Massena & duPont, architects; Jaros, Baum & Bolles, consulting engineers; Turner Construction Co., Philadelphia, general contractors. Steam equipment, air conditioning, and conveyor system installed by Benjamin F. Shaw Co., Wilmington. Plumbing equipment contractors: Unit 1, Paul A. Middleton, Wilmington; Unit 2, P. H. Cronin, New York; Unit 3, T. T. Weldin & Sons, Wilmington.

BOEING AIRCRAFT

AIR CONDITIONING FOR DEFENSE

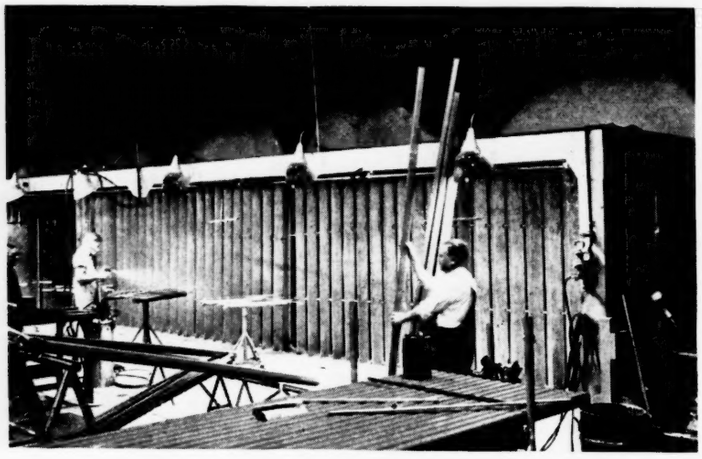
builds twin bomber plants at Wichita, Kan., and Seattle, Wash. These plants will be used for manufacturing and assembling Boeing B-17-E flying fortresses. Plants to be heated by 160 unit heaters served by five 250 hp. boilers.

With the 41-acre Seattle bomber plant of the Boeing Aircraft Company completed and in production after a record 12-month expansion program, The Austin Company has started construction of a 1,320,600-square-foot addition to Boeing's new bomber plant at Wichita, Kansas, which will soon be a twin to the enormous Seattle development.

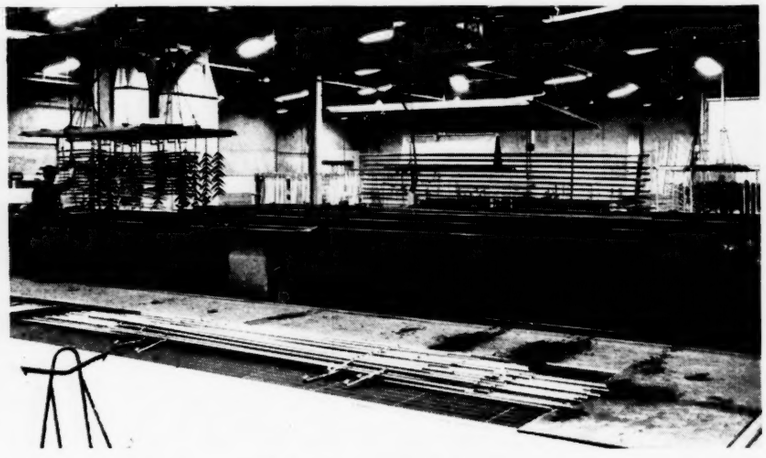
Included in the Seattle plant's 41-acre interconnecting layout are a modern four-story engineering building with 182,000 square feet, a three-story reinforced concrete executive office building having 47,000 square feet, a large boiler house, a two-story personnel building, a new camouflage-paint building and miscellaneous service structures.

Approximately 42 miles of piping carries steam, air and water direct to every position in the plant where such facilities are needed. Forty-six miles of pipe required by the sprinkler system have 20,000 individual sprinkler heads and 75 tons of fittings, exclusive of gate valves which weigh seven tons. Water for this system is furnished in part from a 22-inch city main and the remainder from a 150,000-gallon tank with an electric-driven fire pump having capacity of 1500 gallons per minute.

Plant heating requirements are met by 160 unit heaters which are served by five 250 hp boilers.



Corner of the ventilated ground floor paint shop where aircraft parts are sprayed. Exhaust fans draw off excess spray and fumes. Fresh air is drawn in through panels in the walls which separate the room from the primary shop which surrounds it.

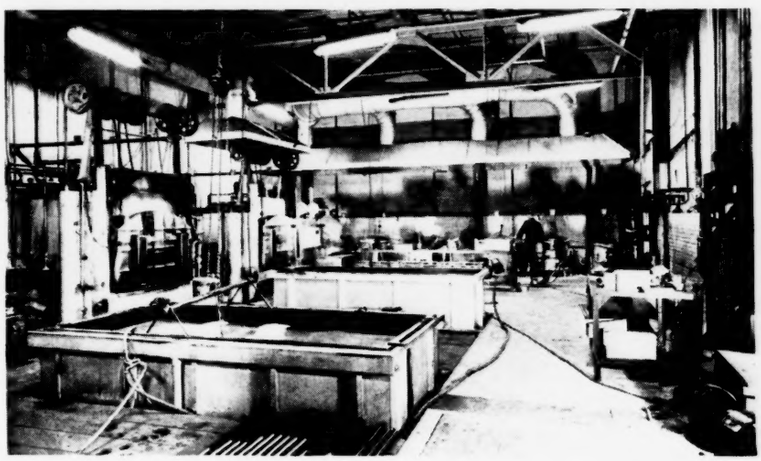


Aluminum alloys are efficiently handled in this anodizing room in the Seattle plant. Following anodizing, the parts are washed and then laid on open floor grilles which serve as drying tables. Through the grilles hot air is fed from a steam hot blast system.

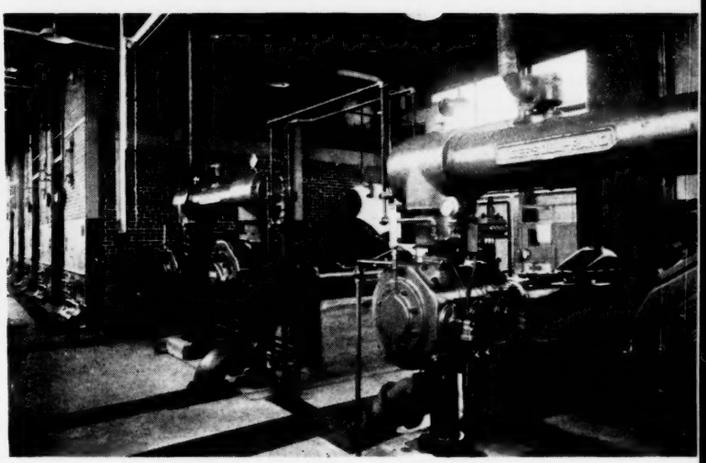
An aerial view of the first unit of the Boeing plant at Wichita. The completed structure will extend between the present plant toward the top of the picture and beyond it at the right.

The Boeing projects described here were designed and built by THE AUSTIN CO.

Three-story office building at the Boeing plant No. 2 at Seattle where the general heating quarters are located. It has a total area of 47,000 sq ft and stands directly in front of a new four-story engineering building of 182,000 sq ft.



One corner of the steel heat treating department, showing the ventilating system for this area, which is completely surrounded by other portions of the plant with no outside walls for natural ventilation.



Inside the boiler house at the Seattle plant showing the five 250 hp boilers, access plates in the floor to piping, and partial view of air compressors. The compressors are each 900 cfm capacity.

Flying fortresses nearing completion in the 300 ft bay at the No. 2 plant at Seattle. This area will be duplicated in the new Wichita plant.

Graphically Determining Turn-on Time for Intermittent Heating Plants

By F. W. HUTCHINSON†

Holme and Giesecke have developed formulas for determining the time to start heating a structure intermittently heated in order to attain desired indoor conditions at a given time. Use of these formulas, however, has been somewhat complicated and time consuming. The author has developed a graphical solution for such problems, here described, abstracted from the author's paper "Graphic Analysis of Intermittent Heating", presented before the National District Heating Association in June. Derivations of the formulas in the Appendix of the author's original paper are not included but are available in the N.D.H.A. Proceedings for 1941.

EXACT analytical determination of the optimum time to start heating a structure with intermittent occupancy is difficult and time-consuming. Wherever possible, experimental investigation on the actual building will lead to equal or greater accuracy of results with a probable lesser expense of time. However, in the case of buildings in process of design or erection and for existing buildings where great accuracy is not essential, certain idealizations can be made which simplify the analytical method and permit its application to problems in practice.

Simplified equations based on systems in which steady state conditions are said to exist at each time interval during the transient period and for an unvarying outside temperature during this period have been discussed . . . and applied to the construction and analysis of heating and cooling curves . . . The intent of this paper is to establish a completely graphical solution of these equations and show how, from the graphs, analysis of intermittent heating and determination of the optimum start-up time can be carried out without calculation and with a knowledge only of the physical characteristics of the structure.

Cooling Equation. The cooling equation is

$$\theta_c = \frac{Q}{q} \log_e \frac{t_{i_1} - t_o}{t_{i_2} - t_o}$$

where θ_c = hours for inside air temperature to drop from t_{i_1} at time 0 to t_{i_2} at θ_c when outside air temperature remains constant at t_o;

Q = thermal storage constant for the structure
= $(Q_1 + Q_2 + Q_3 + \ldots\ldots\ldots Q_n)$,
where Q_1, Q_2, etc., are thermal storage constants and are functions of the type of construction; they can be obtained directly from Graph I when the area, thickness, density, specific heat and overall heat transfer coefficient of each part of the structure are known; and

q = heat transfer constant
= $(q_1 + q_2 + q_3 + \ldots\ldots\ldots q_n)$
where q_1, q_2, etc., are individual constants for each heat transmitting part of the structure. Knowing the area, overall heat transfer coefficient and outside air requirements for ventilation, the value of q_1, q_2, etc., can be read from Graph I.

With Q and q from Graph I, the value of θ_c can be directly determined from Graph II.

Heating Equation. The heating equation is

$$\theta_h = \frac{Q}{q} \log_e \frac{1}{1 - \frac{q}{R}(t_{i_2} - t_o)}$$

where θ_h = hours for inside air temperature to raise from t_o to t_{i_2} when outside temperature is constant and heating system operates at maximum capacity of R Btu per hr. With Q and q from Graph I the value of θ_h can be directly determined from Graph III.

The method of solving a typical problem by use of the graphs is detailed in the example which follows. Note particularly that the constants Q and q have given values for any one structure and are dependent only on the physical constants of the construction; they are completely independent of the inside and outside temperatures and of the capacity of the heating plant. Thus Q and q are essentially architectural constants and can be evaluated even before the type, size, or requirements of the heating system have been determined. The heating and cooling times, however, are dependent on the operating range and plant capacity as well as on the thermal characteristics of the structure.

The procedure given in the following example is in greater detail than will usually be found necessary. The order of the work is given in the form that is usually best adapted to rapid application.

Example: A large industrial building is to be constructed as follows:

Exterior surfaces: 8,000 square feet of exterior wall (exclusive of glass). Wall is of 6 in. concrete with 4 in. cut stone facing outside and is finished inside with

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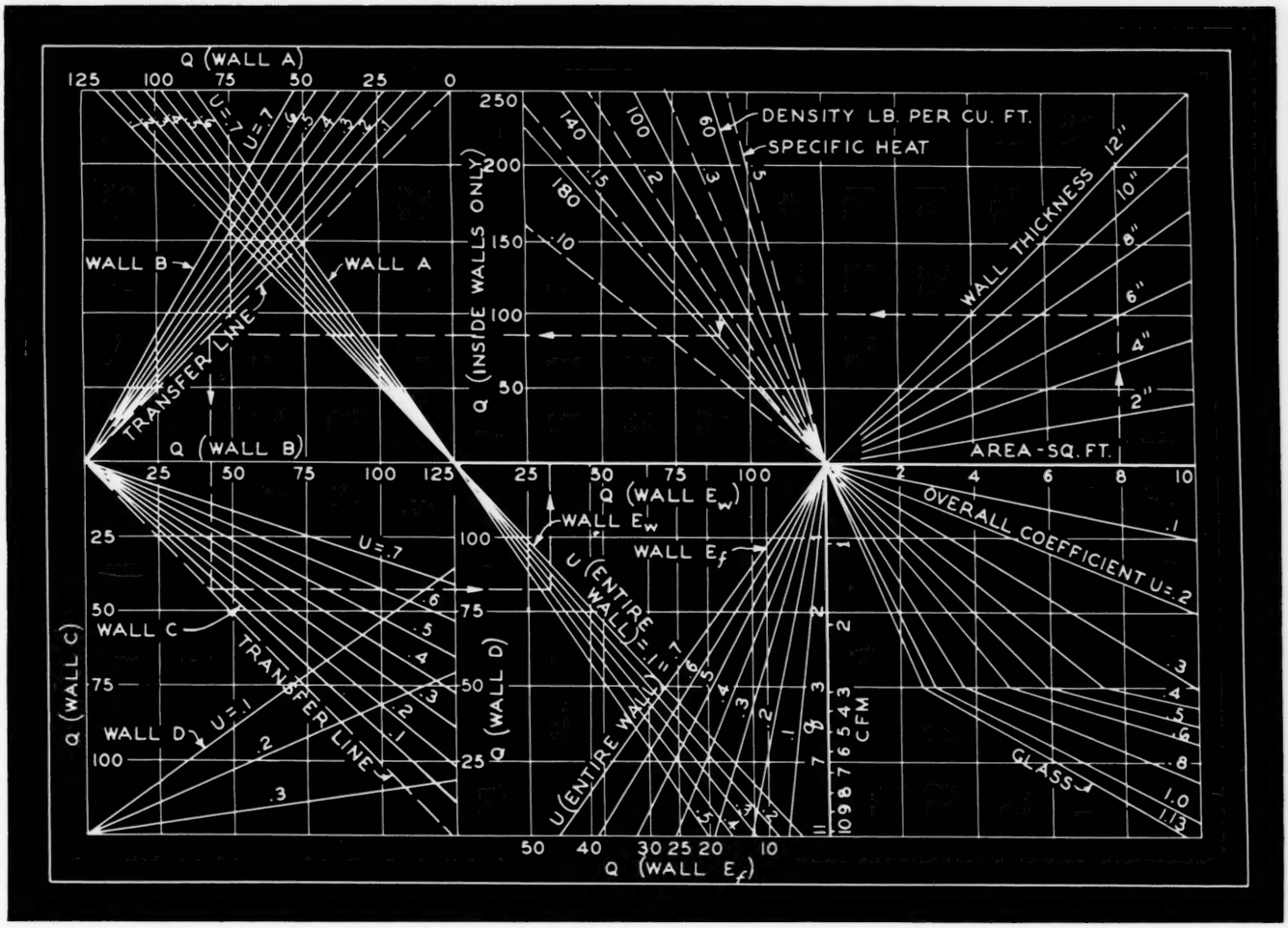


Graph I. Graphical determination of heat storage, (Q), and heat transfer, (q), constants for intermittent heating analysis. In the above, wall B, plain outside, 1/2 in. plaster on wall inside; wall C, plain outside, 3/4 in. plaster on metal lath (furred) inside; wall D, plain outside, as C but 1/4 in. insulation in furred space; wall E_w, as C with 4 in. cut-stone veneer, Q for wall exclusive of veneer; and all E_f, as C with 4 in. cut-stone veneer, Q for veneer only.

¾ in. plaster on metal lath, furred. The concrete has a density of 140 lb per cu ft, and a specific heat of 0.15 Btu per lb per F. The facing has a density of 160 lb per cu ft, and a specific heat of 0.20 Btu per lb per F. The overall coefficient of heat transfer is 0.36. 2,500 sq ft of roof consisting of 4 in. concrete slab unfinished on both sides (U = .9). Storage and transmission characteristics of the basement are neglected. 2,000 sq ft of window area (U = 1.13).

Interior surfaces: 10,000 sq ft of interior (non-transmitting surface) floors consisting of 4 in. concrete slab. 12,500 sq ft of interior partitions consisting of 4 in. clay tile plastered (½ in.) on both sides, with a density of 130 lb per cu ft, and a specific heat of 0.22. Storage characteristics of furniture are not taken into account in this example, but the methods of including a term for this effect should already be clear. Ventilation requires 4,000 cfm of outside air. The heating system has a maximum output of 820,000 Btu per hr.

To assist in establishing an operating procedure for the heating system, the following information is required: The thermal storage constant, Q, of the structure; heat transfer constant, q, of the structure; time required to cool from 70F to 50F inside air temperature when outside temperature remains constant at 30F; time required to raise inside air temperature from 50F to 70F when outside temperature is constant at 30F; cooling curve for this structure; heating curve for this structure.

The problem is to determine the optimum time for starting to heat if occupancy is such that temperature must be held at 70F from 9:00 a.m. to 4:30 p.m., but can vary as may be desired during the night hours (Based on t_o = 30F). Determine heat required when so operating and compare with requirements for continuous heating.

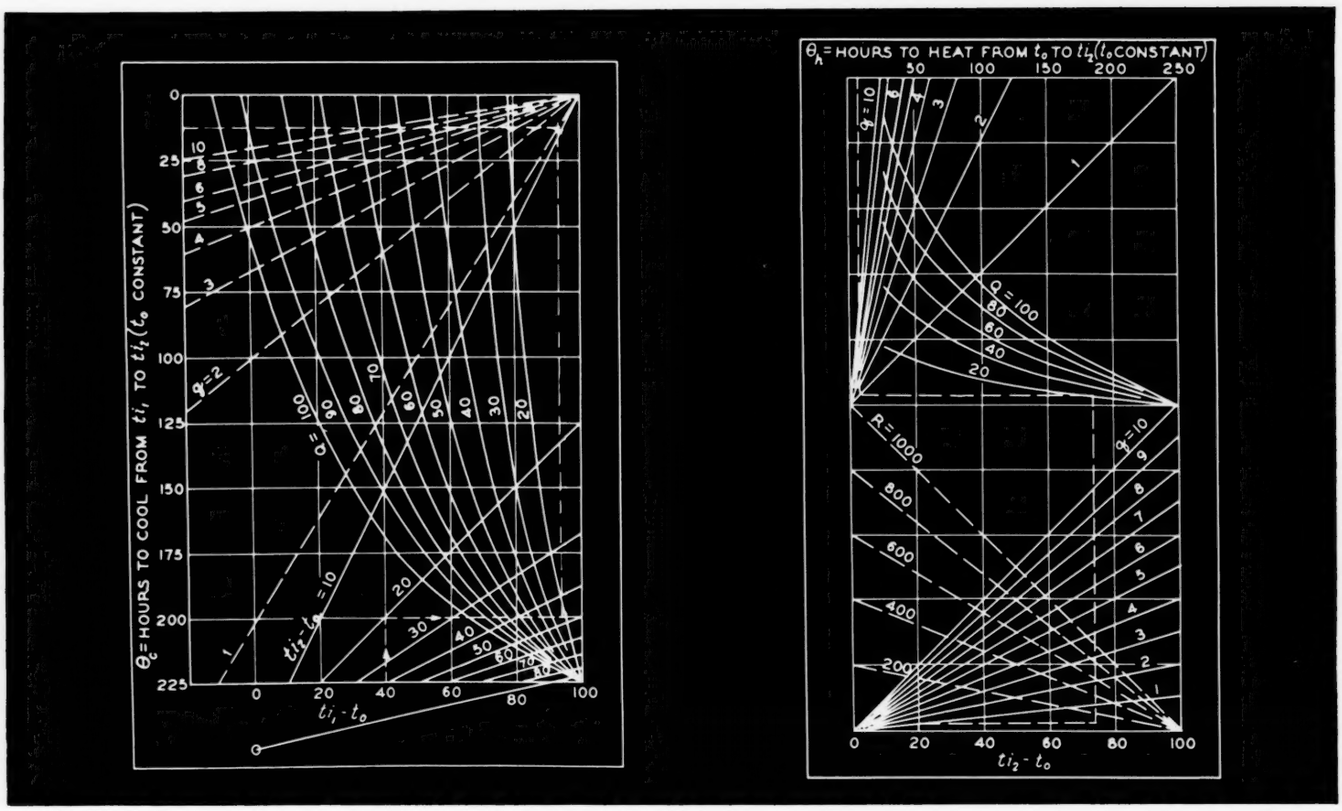
Solution: Determination of thermal storage coefficient, Q:

Q_w for exterior wall consists of two parts,

Q_c for the concrete and plaster, and

Q_f for the stone facing.

To obtain Q_c enter Graph I at 8 sq ft (left center), (and follow the dotted line for this example); rise to 6 in. wall thickness, move horizontally left to intersect density line (solid line) for 140 lb per cu ft, drop to intersect specific heat (dashed line) = 0.15, then move to left to transfer line, drop to transfer line in lower left quadrant, move right to intersection with U = .36 for wall E_w and then rise to read Q_c = 32.5. Since the actual area is 8,000 sq ft rather than 8 sq ft, it fol-



Graph II. Graphical solution of the cooling equation.

Graph III. Graphical solution of the heating equation.

lows that $Q_c = 32.5 \times 10^3$. Similarly for Q_f enter at 8, rise to 4 in., cross to 160, rise to 0.2, cross to transfer line, drop to transfer line, cross to $U = .36$ for E_f and drop to read $Q_f = 8.13$ or (corrected for 8,000 sq ft), $Q_f = 8.13 \times 10^3$. Then $Q_w = Q_c + Q_f = (32.5 + 8.13)10^3 = 40.6 \times 10^3$.

Q_r for roof is obtained by entering Graph I at 2.5 sq ft, rising to 4 in., crossing to 140, dropping to .15, crossing to $U = .9$ for wall A, then rising to read $Q_r = 5$ or (corrected for 2500 sq ft) $Q_f = 5 \times 10^3$.

Q_g for window area is negligible.

Q_{if} for interior floors: Enter at 10, rise to 4 in., cross to 160, drop to 0.15, cross to scale for inside walls (vertical scale, top center) where read $Q_{if} = 70$ or (corrected for 10,000 sq ft) $Q_{if} = 70 \times 10^3$.

Q_{ip} for interior partitions: Enter at 1.25, rise to 4 in., cross to 130, rise to 0.22, cross to scale for inside walls where read $Q_{ip} = 11$ or (corrected for 12,500 sq ft), $Q_{ip} = 110 \times 10^3$.

Total thermal storage coefficient for the structure,

$$Q = Q_w + Q_r + Q_{if} + Q_{ip}$$
$$= (40.6 + 5.0 + 70.0 + 110.0)\ 10^3$$
$$= 226 \times 10^3$$

Determination of heat transfer coefficient (q): To obtain q_w for exterior wall enter at 8 (area), drop to $U = .36$, move left to read (vertical scale, lower right) $q = 2.9$ (for 8000 sq ft) $q_w = 2.9 \times 10^3$.

For q_g of glass enter at 2, drop to 1.13, cross to read $q = 2.3$, or $q_g = 2.3 \times 10^3$.

For q_r of roof enter at 2.5, drop to .9, cross to read $q = 2.3$ or $q_g = 2.3 \times 10^3$.

For q_{air}, opposite 4 on CFM scale (Graph I, vertical scale, lower right), read $q = 4.2$ or (corrected for 20,000 CFM)

$q_{air} = 4.2 \times 10^3$.

Total transmission coefficients

$$q = q_w + q_g + q_r + q_{air}$$
$$= (2.9 + 2.3 + 2.3 + 4.2)\ 10^3 = 11.7 \times 10^3$$

Determination of time required to cool from 70F to 30F when outside temperature is constant at 30F:

For solution, follow dotted lines, Graph II. Since $t_{i_1} - t_o = 70 - 30 = 40$, enter Graph II at 40, horizontal scale, rise to $(t_{i_2} - t_o) = 50 - 30 = 20$F (diagonal straight lines), cross to right to intersect $Q = 22.5$ (curved lines), rise to $q = 1.17$, cross to left and read cooling time as 13.3 hours.

Determination of time required to heat from 50F to 70F with outside temperature constant at 30F: In determining the time to heat from 30F to 50F, note that the constants q, Q, R having actual values of 11.7×10^3, 226×10^3 and 820×10^3 can be conveniently rearranged to the relative values 1, 19.3 and 70. Enter Graph III at $(t_{i_1} - t_o) = 70 - 50 = 20$ (follow dotted line), rise to $q = 1$, cross right to $R = 70$, rise to $Q = 19.3$, cross left to $q = 1$, rise to read time as 6.5 hours.

Similarly the time to heat from 30F to 70F is found to be 16 5 hours. Thus the required heating time from 50F to 70F is $16.5 - 6.5 = 10$ hours.

To determine the cooling curve for the structure, by the method outlined previously, points on the cooling curve can be determined and a curve drawn, as shown in Graph IV.

Similarly, the heating curve for the structure can be determined by computing a number of points (for constant t_o and given R) and the curve plotted. This is done in Graph V.

Optimum Time to Start Heating

In the example, the inside temperature need not be maintained after 4:30 p.m., so that at that time heat will be turned off and the structure allowed to cool. Thus the time zero (Graph IV) will now be called 4:30 p.m. At 9 a.m , 16½ hours after the heat is turned off, the temperature must again be 70F; thus the heating curve must be so placed that it crosses the 70F line 16½ hours after cooling begins. By pure coincidence the position of the heating curve in Graph IV already meets this condition and is therefore ready for use.

If any conditions of occupancy other than those of this example existed the position of the heating curve of Graph IV would have to be adjusted. Suppose for example that the 70F temperature were to be maintained from 7 a.m. to 10 p.m. Then the heating curve would have to cross the 70F line 9 hours after cooling started. Noting that the upper portion of the heating curve is approximately a straight line, it is seen that readjustment to the desired new position could be easily accomplished by drawing a straight line parallel to the heating curve of Graph IV, the upper end passing through the intersection of the 9 hour and 70F coordinates.

Returning to the given example, a time scale is now placed across the top of Graph IV: From this, the temperature at any time during the night hours can be determined and examination of the figure reveals that the optimum time for starting the heating system is 1:30 a m. If heating were started later than 1:30 a.m., the building would not be at 70F by 9 a.m., while if heating were started before 1:30 a.m., the temperature would reach 70F before 9 a.m. and consequently unnecessary energy would be dissipated.

The coordinates of Graph IV are degrees and hours so the area of this figure is in degree hours. The heat transfer constant of the structure, q, is in Btu per degree hour, so that q multiplied by any area of Graph IV will give Btu. Therefore, any area on this chart represents a quantity of heat and the saving due to intermittent heating with optimum start-up is the area *abc*. Anything which will increase this area will increase the advantage of intermittent heating. Note that enlarging the heating system would increase the slope of *bc*, make the time of start-up later, increase area *abc* and increase both the relative and absolute savings, neglecting possible loss due to greater investment. Note also that increasing the slope of *ab*—that is, increasing the transmission losses so the structure will cool more rapidly—likewise increases area *abc* and results in a greater relative saving (over cost of continuous heating) but will, of course, result likewise in a greater absolute cost for heat. Thus a light structure having little thermal capacity and large transmission losses offers much greater savings when intermittently heated than does a heavy well insulated structure.

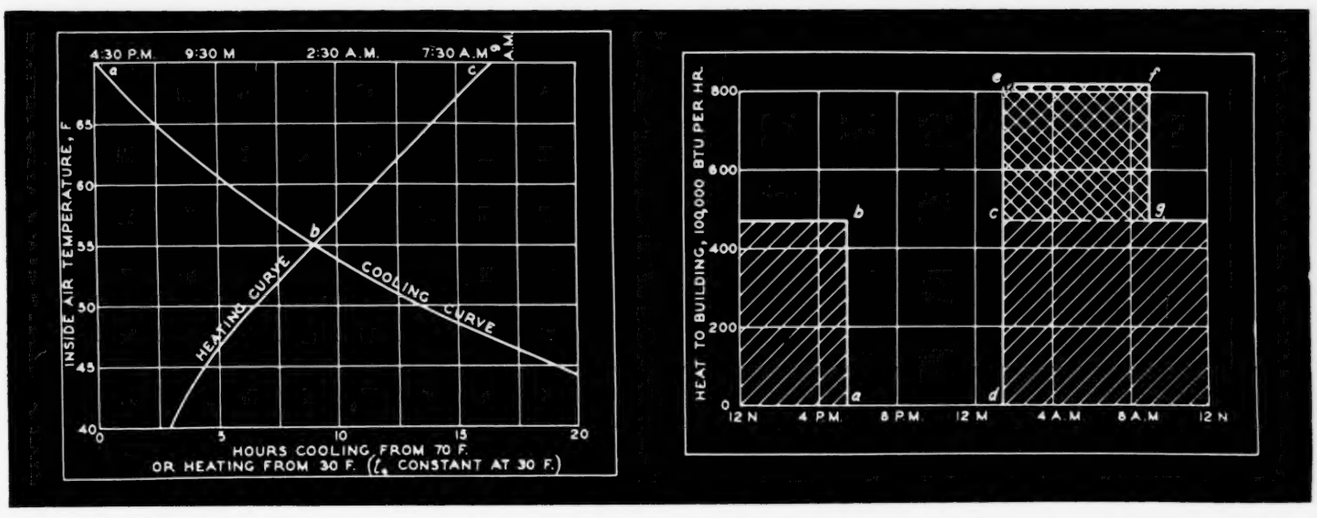
In connection with the energy requirements for intermittent and continuous heating, Graph V shows the rate of heat supply to the structure as a function of time for an operating schedule in accordance with Graph IV. From 9 a.m. to 4:30 p.m. the structure is assumed at steady state and heat is required at a rate of (70 — 30) $11.7 \times 10^3 = 468{,}000$ Btu per hr. At 4:30 p.m. heating ceases and no further energy is supplied until 1:30 a.m., when heating comes on at maximum capacity (R = 820,000 Btu per hr) and continues at this rate until the air temperature reaches 70F at 9 a.m. At this time the thermostat acts to reduce the supply of heat. The energy which would have been supplied between 4:30 and 1:30 a.m. if operation were continuous ($468{,}000 \times 9 = 4{,}212{,}000$ Btu) is not all saved since the output from 1:30 a.m. to 9 a.m. exceeds the value for continuous heating by (820,000 — 468,000) 7½ = 2,490,000. The net reduction in daily heat requirement as a result of intermittent heating is therefore

$$4{,}212{,}000 - 2{,}490{,}000 = 1{,}722{,}000 \text{ Btu}$$

which is $\dfrac{1{,}722{,}000}{468{,}000 \times 24} = 15.3\%$. The saving is shown in Graph V by area *abcd* minus area *cefg*.

Graph IV. Curves for structure described in the example.

Graph V. Time-energy plot for the example.



Theory Vs. Practice

By T. W. REYNOLDS

Increasing the Capacity of Existing Radiators

NATURALLY the thought that comes quickest to mind when part of all the radiators are below heat loss requirements is to fill the deficiency by adding surface, forgetting at least for the moment that a thorough survey might disclose various ways of getting more out of the equipment already on hand. Possibly there are radiator covers, humidity pans, books or plants which may be removed from the radiators so as to increase their output, while a little attention to the air valves in the way of cleaning or replacement may give some surprising results.

Putting insulation on in some places and taking it off in other places may seem like an anomaly, nevertheless taking it off of the basement pipes helps to heat basement rooms or to make the first floor warmer. On the other hand, where the boiler is unable to develop enough steam for all requirements, putting insulation on the basement pipes will transfer the heat as conserved by the covering to the radiators in the rooms above where the heat can be used to better advantage.

The radiators in an open hot water system can be increased in output if the system is put under pressure by means of a pressure tank, reducing valve and relief valve, though such equipment is of more value with oil than with coal. Obviously, a hand-fired plant must be forced manually so as to maintain the higher pressure and temperature, and there is no surety that this will be done.

If the open expansion tank is in good condition and able to stand the pressure it may be left where it is, with the opening plugged, or it may be re-used in the basement, except that a tank on a downfeed system cannot be used in a basement, but must be installed at the high point of the system in the attic in order to vent the system. A tank left in a closet has the advantage that it will continue to warm the adjacent room to a certain extent. A tank left in the attic should be protected against freezing by insulation.

A hot water system with its feeble motive power when getting under way may be very sluggish in bringing the temperature up to normal, but once this is finally accomplished the large amount of hot water stored in the system may raise the room temperatures far above normal. The system may be greatly improved by the installation of a flow valve and a circulator to start and stop the flow of water. A circulator is of particular help where the second floor radiators are below requirements and the boiler under size.

A by-pass should be provided around the circulator in a coal-fired plant, so that the system may continue to work on gravity when required. If this is not done, the fire will require frequent attention as there will be no place for the heat to go when the circulator shuts off. The by-pass should be the same size as the main return, with a valve installed in the by-pass for throttling the circulation under gravity conditions as may be required in some systems so as to prevent overheating.

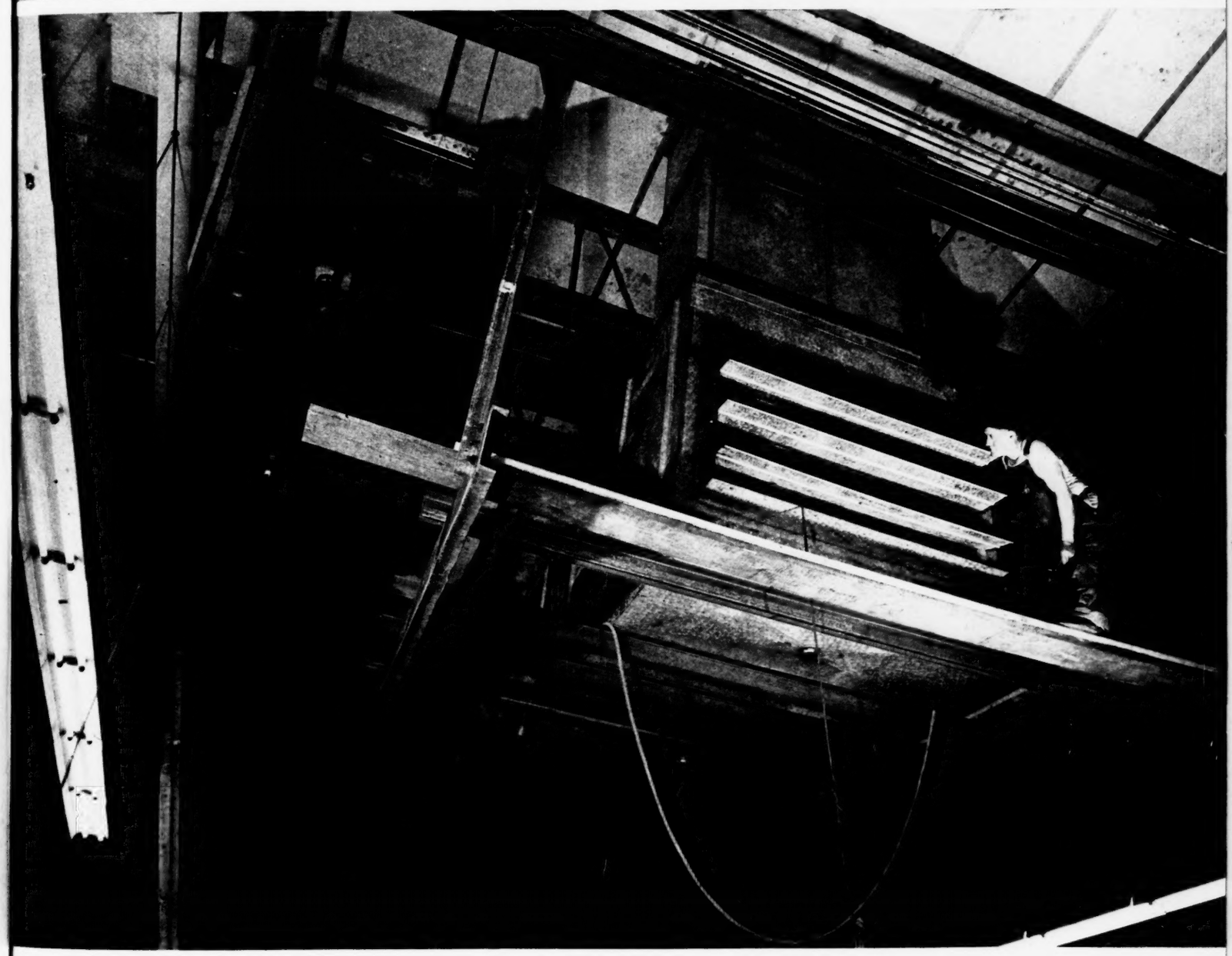
When a circulator is used it is important that the system be well vented at the high point, as there is a tendency for air to be carried past the vent point due to the faster moving water. Where the system is a one pipe system there is a probability that any air carried along to the main may air bind at the special branch fittings in the main.

Installation of a circulator is usually the solution to a troublesome hot water heating system, though there are times when something more than this is required. A case in mind was one where a branch main to five radiators on the second floor of a house was run with but slight grade in the second floor construction. The radiators referred to were always stone cold; a circulator was installed, but no improvement resulted until the piping was removed and blown free of sediment. Then the radiators heated without pipe changes.

There are many other things which may be done around a house to make conditions more livable, save fuel, and enable one to reduce the load to fit the existing undersize plant, so that expensive changes no longer are necessary. Each of these items may give substantial savings in itself. Obviously, as each is installed the individual saving becomes less and less, simply because the preventable losses are greatly diminished each time an improvement is made.

A check list would cover such items as weatherstripping, insulation, double glazing, storm windows and doors, windows kept locked, shades down at night, replacement of any missing fireplace dampers, shrubbery around house, moderate use of open windows in sleeping rooms and the heating of as few rooms as possible. Closing doors of the various rooms at night and the doors of rooms which are seldom used in the day time, such as those on the upper floors, will provide resistance to the in and out of filtration, thus making for savings and more comfortable quarters on windy days; while keeping the lounge or similar furniture a little away from the cold outside walls will make the furniture more comfortable for use, in which event the room temperatures need not be so high as they formerly were.

PROFITS IN AIR



A SECTION OF "HEATING & VENTILATING" SHOWING HOW INDUSTRIAL PLANTS PROMOTE PROCESSES AND PROFITS BY SCIENTIFIC CONTROL OF ATMOSPHERIC CONDITIONS

PROFITS IN AIR

BURMA-SHAVE

originates in the new home of Burma-Vita Co. at Minneapolis, with year-round air conditioning, and with summer cooling by well water. Careful temperature control eliminates back-and-forth cooling table system formerly used.

By MILTON FIGEN

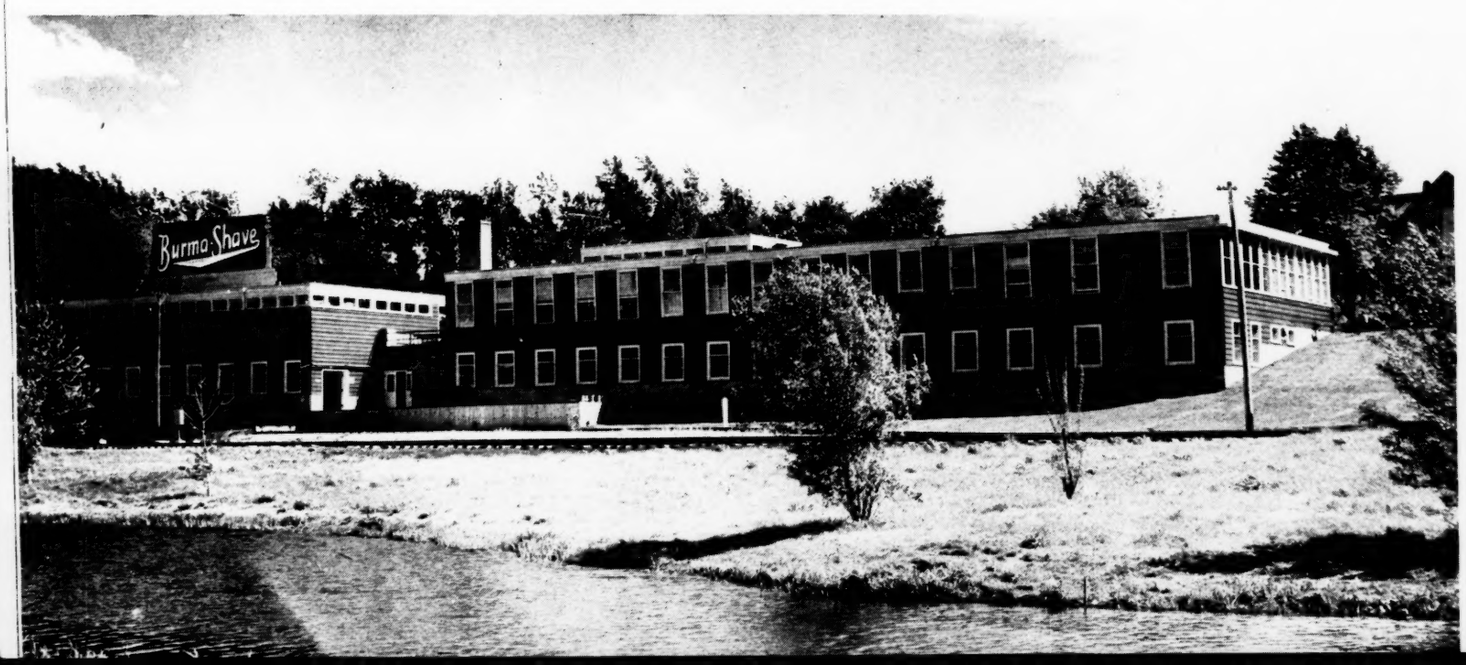
SIMPLICITY of design and economical operation are reflected in the air conditioning system, employing well water cooling and hot water heating, of the new plant of the Burma Vita Company, Minneapolis. The firm is widely known as the originator of the roadside jingle type of advertising which, while it entertains travelers on highways all over the nation, extols the virtues of "Burma Shave."

The Burma Shave plant is built of wood, excepting only the foundation. It is insulated throughout with four inches of rock wool with wall-board on each side and with a moisture barrier paper beneath the clapboard exterior. All windows are of the double-pane type, obviating the need of storm windows. In addition, protection from the sun's heat is afforded by the use of Koolshade sunscreens.

Discovery that the property was located over a preglacial Mississippi River bed and that a well need be sunk only 70 feet to tap cold water suggested the possibility of installing a cooling system for the entire building. With this idea in mind it was decided to circulate hot water for heating, utilizing the same equipment for both cooling and heating service. Use of the well-water cooling involved only a relatively small additional investment over what the heating alone would have cost, excepting for the cost of sinking the well which the firm required for its processing work, regardless of whether it was to be used for cooling the building.

The area served by the air conditioning system includes the plant's general offices and laboratory, occupying 31,500 cubic feet on one floor, and the factory proper aggregating 100,000 cubic feet and located partly on the same floor and partly on the lower floor.

The plant of the Burma-Vita Company in Minneapolis, heated by hot water and cooled by well water.



HOW INDUSTRIAL PLANTS PROMOTE PROCESSES AND PROFITS BY SCIENTIFIC CONTROL OF ATMOSPHERIC CONDITIONS

PROFITS IN AIR

No. 55 OF A SERIES SHOWING HOW INDUSTRIAL PLANTS PROMOTE PROCESSES AND PROFITS BY SCIENTIFIC CONTROL OF AIR CONDITIONS

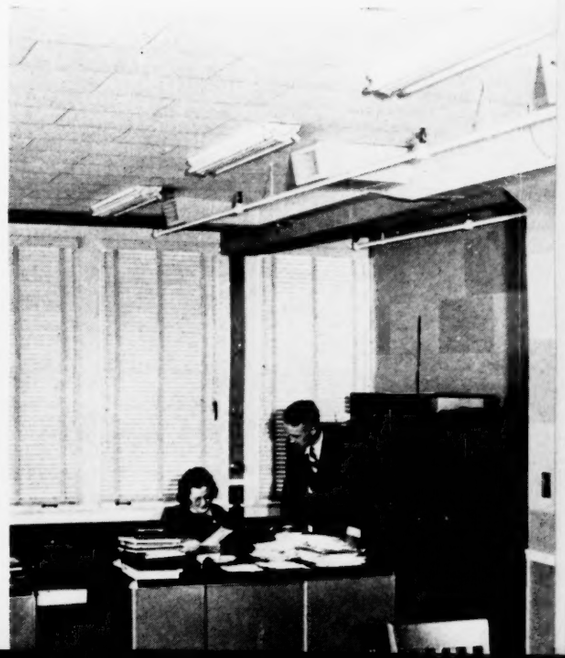
The office and laboratory section is served by a two-zone air conditioner suspended from the ceiling of the factory space adjoining, and providing heated or cool air through ducts. The conditioner has six-row counterflow coils, a screen drip type humidifier is used, viscous glass wool filters, and a centrifugal blower operated by a 1½ hp cycle motor. One zone serves the south wall of the office, consisting almost entirely of windows. Here, on sunny days, even with low temperatures, the air conditioner is supplying outside air tempered to about 58F. The north side gets no sun at any time, and, being on a separate zone, receives heating service all winter.

The combination of well water cooling and hot water heating simplified the air conditioning problem for this area in that only one coil and one control valve per zone is required.

Air conditioning service to the factory is provided by seven combination cooling and heating units. Six of these are used for both cooling and heating, one for cooling only. Each unit is under separate control designed to counteract the radiant effect of the various types of processing equipment in the plant, some of it heat emitting and some heat absorbing.

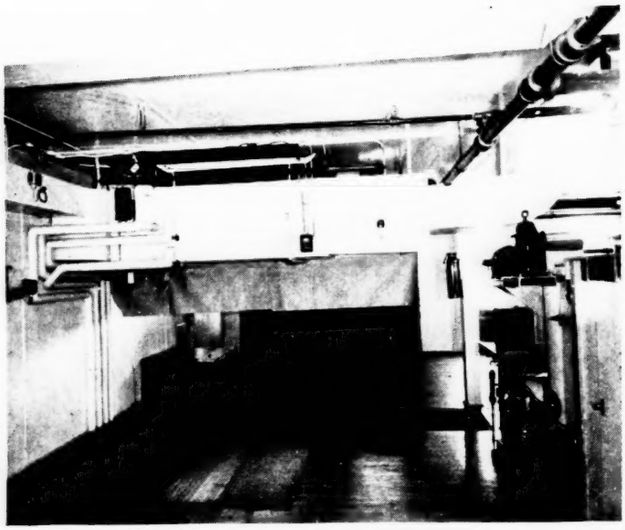
A modulating-type motor-operated valve is installed in the water supply line to each coil and is controlled by a thermostat in the conditioned space. One thermostat on the north side controls one valve and a second thermostat on the south side controls a second valve. These valves are also connected to a low-limit controller in the air supply duct to each zone to temper winter ventilation air.

The thermostats have two elements. One element opens the valve on a falling temperature, on a modu-

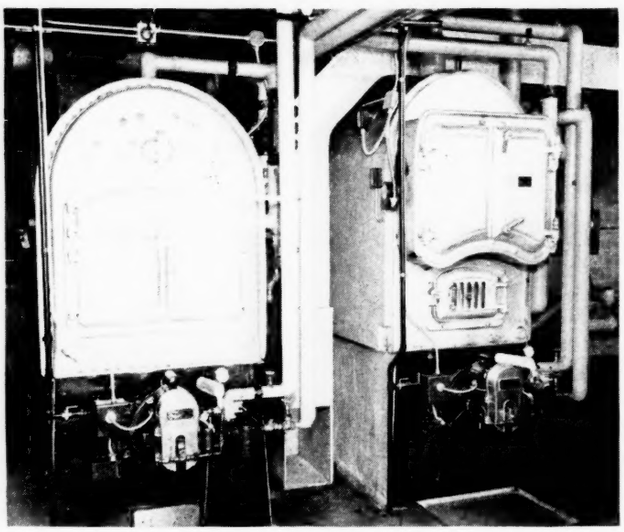


(Left) A view of the Koolshade screens used in the Burma-Vita plant to reduce heat gains from the sun. (Right) A view in the office showing the overhead ducts which are used year-round.

One of the McQuay unit heaters in the packing department.



One of the seven combination heating and cooling units, each under individual control so as to provide zoning, depending on the load.



Water is heated in these Kewanee boilers fired by Enterprise oil burners.

lating cycle; the other on a rising temperature, on a two-position cycle.

A motor-operated damper is located in the outside air duct controlled by a manually operated controller and by a low limit temperature controller in the chamber where the ventilation air and recirculated air are mixed to protect the coils from freezing by the introduction of an excess amount of ventilation air when the outdoor temperature is low.

A humidistat in the air conditioned space opens or closes a solenoid valve in the humidifying water supply line to satisfy winter humidifying requirements.

The motor-operated valves, fresh air damper and solenoid humidifying valves are interconnected with the fan motor through a relay, causing these devices to go to the closed position whenever the fan motor circuit is broken.

Each of the six unit heaters is connected to a line voltage mercury switch type room thermostat to control the fan motor for winter operation. Each unit is also equipped with a four speed manual switch to reduce or increase heating capacity to meet seasonal requirements. Each thermostat is equipped with a summer-winter switch to throw the thermostat in or out of control. A constant air circulation is used in the summer, with cooling requirements regulated manually by throttling the cold water supply by means of hand valves at each cooler. Each unit has a condensate drain connection.

The installation was designed on the basis of 95F dry bulb and 75F wet bulb outdoor summer temperatures and indoor temperatures of 80F dry bulb and 66.5F wet bulb. In winter an indoor temperature of 72F is provided, with a relative humidity of 40%. Total air circulation in the offices and laboratory area is 2,800 cfm; in the factory, 14,000 cfm. The total cooling rating is 30 tons, based on a water temperature of 52F.

After the jars of Burma-Shave are filled they are left on a table to cool before being conveyed to the capping machine. The controlled temperature makes this cooling period non-variable, and has eliminated the old back-and-forth cooling system used in the old plant.

In addition to the heating supplied through the central plant air conditioner and factory units, convectors are located in rest rooms and in the public vestibule. These radiators are so valved that they can be cut out in the summer. They are served by the same water circulation loop as is the air conditioner and unit heaters.

The boiler supplying hot water to the entire system is a Kewanee with a capacity of 5,200 feet of direct radiation and is fired by an Enterprise oil burner which burns No. 5 oil.

The air conditioning system was designed by R. W. Evans, Minneapolis. Air conditioner coils and unit heater-coolers are by McQuay, Inc. Minneapolis-Honeywell controls are used. The screen drip humidifiers and motors are General Electric, with Bayley blowers. Installation was by the Conditioned Air Equipment Company and The Gruden Company, St. Paul. Magney-Tusler & Setter, Minneapolis, were the architects.

Westinghouse Electric & Mfg. Co.

air conditions its new windowless fluorescent lamp plant at Fairmount, W. Va., with water from an abandoned mine, electric filters and ultra-violet lamps. Air "curtains" are used between different departments due to character of gases and other materials involved.

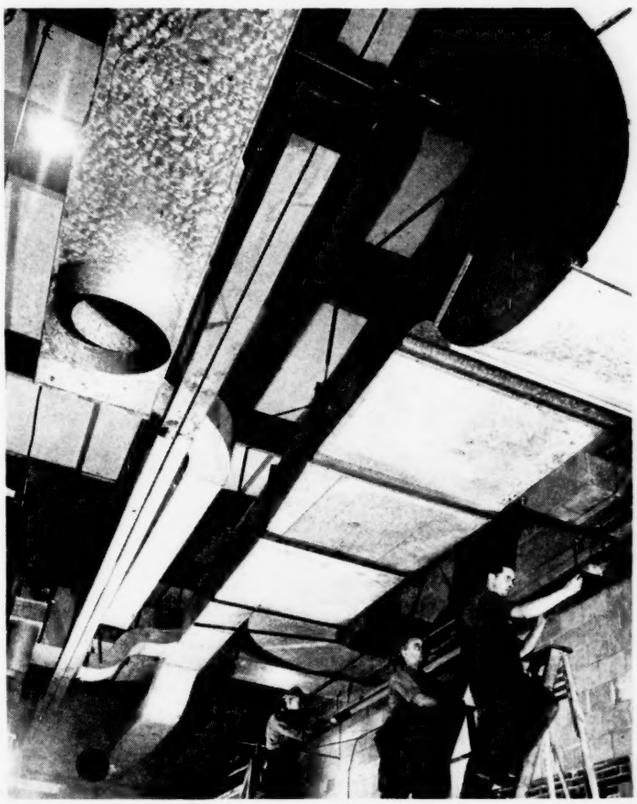
By C. L. NORDHEIMER† and ALEXANDER A. DZUBAY‡

INSTEAD of compressors, 2230 gallons per minute of 55F water from an abandoned mine a mile away provides exceptionally low cost summer cooling for the 200,000 sq ft Westinghouse Fluorescent Lamp Plant newly completed at Fairmont, W. Va. The total 133,425 cu ft per minute of conditioned air winter and summer is cleaned by 13 sets of Precipitron electric filters and irradiated by a bank of 600 Sterilamps. Zone controlled air conditioning is used throughout this "blackout" plant, with direct-fired gas heaters for winter conditions.

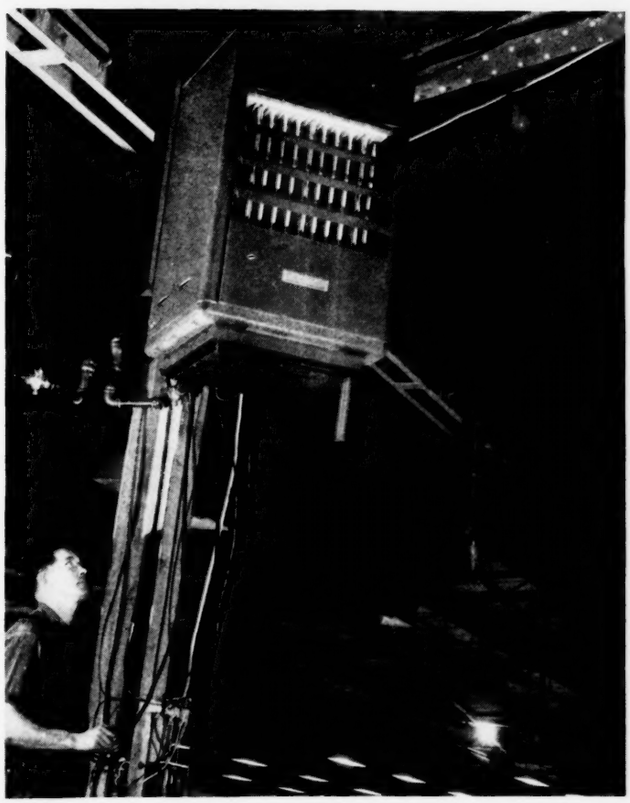
The zone system provides reliability and, because of unit flexibility, gives uniform conditioned air to meet special needs of fluorescent lamp manufacture. A total of 13 zones or systems are necessary to deliver the heated or cooled air to the various departments. For example, it was advisable to install complete fresh air supply systems in departments working with liquids or gases. This is especially true of the Solvent, Mixing, Coating and Drying Departments where the air in each of these departments can not be recirculated due to the nature of the gases and liquids employed in the manufacturing process. The Ball Mills Department presents the peculiar problem of dispelling fine dust particles. Provision is made to avoid any direct air communication between the Ball Mills, Cement Mixing, Manufacturing, Shipping and Receiving Departments. This is accomplished by a unique arrangement known as an "air curtain," which prevents the fine dust, cement particles, and any escaping gases from passing through the various departments. The solvent room is provided with individual exhaust systems connected to the drainage piping. The purpose of this is to have available at

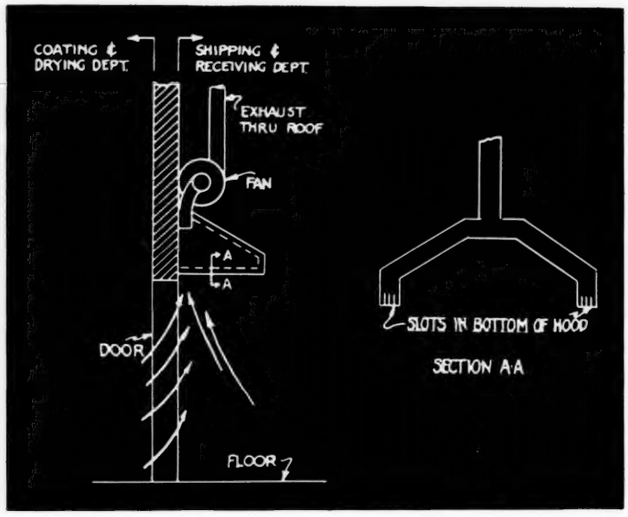
†Construction Dept., Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
‡Consulting Engineer, Pittsburgh, Pa.

A view of the duct work used to distribute conditioned air in the fluorescent lamp plant.



One of the 17 Reznor gas-fired unit heaters in one of the areas not covered by air conditioning.





Air curtain which prevents fine dusts and gases from passing from department to department.

all times an emergency system to exhaust poisonous gases in case of a breakdown in the general system.

In each of these departments 100% fresh heated air is furnished by a fan located in the Receiving Department; no recirculated air is used due to the gases and dust present. Independent exhaust systems in each room remove the air which is cleaned through dust collectors before it is released into the atmosphere outside.

A special dehumidifying system is built into the Coating and Drying Department. Here no recirculated air is used due to the nature of the manufacturing process.

Each piece of manufacturing equipment creates its own air conditioning problem. The intense heat developed by some machines, the gases escaping from liquids, the almost invisible dust particles and numerous other conditions are each eliminated by individual systems of varying types.

The office section is designed to furnish heated or cooled air into the various rooms, and provisions are available to furnish 100% fresh air whenever and wherever required. The air in this portion of the building is distributed through ceiling outlets which are also used to exhaust air from the same rooms at the rate of 3 air changes per hour. To insure positive ventilation, there has been installed a series of booster fans which bring the air back from the rooms and discharge the air into the outside atmosphere or to the supply fan. The system serving the cafeteria is similar to that serving the office section and supplies 6 changes of air per hour.

The main manufacturing plant is provided with fresh heated or cooled air through unit systems which distribute the air through various ducts. Special grilles are used to control the direction of the air into the working area.

Recreation rooms, wash rooms, machinery room, and others are furnished with heated or cooled air as may be required. This is accomplished through unit heaters, duct work, and ceiling type outlets. Some of the discharge outlets recirculate the air from the rooms back to the fans or exhaust it to the atmosphere.

The Receiving and Shipping Departments are heated by direct fired unit Reznor gas heaters without duct work or grilles. During the summer these units circulate but do not cool the air.

In all departments, excepting the Receiving and Shipping, the air is cleaned by Westinghouse Precipitrons. Another protective feature of the heating and cooling systems is the use of Westinghouse Sterilamps in all ducts. Some 600 of these Sterilamps remove germs and various forms of bacteria from the air to insure the health of the workers. These lamps are located in the air conditioning ducts and operate at 95 to 98% efficiency.

Approximately 2230 gpm of water is used for cooling the water circulated in the cooling coils. This water is pumped from an abandoned mine and discharged back into the mine where possible; should this water stir up the mine water, provision is made for its discharge into the storm sewer. The water is pumped into an underground concrete reservoir containing coils through which city water to air condition the building is circulated and thereby cooled in a closed system. Corrosive impurities in the mine water prevent its direct use.

During the winter 18,020 cu ft of 500 Btu gas will be consumed per hour to heat the building when and if the outside temperature is 0F.

The air will be delivered to the various departments having a temperature of 10F lower than the outside temperature, and maintain a relative humidity of approximately 50%.

An air curtain is provided for between two departments. This is located at the door opening, to stop, as far as possible, the mixing or allowing the air to go from one department into the other. See the drawing.

Air Conditioning for Fur Storage

Protection against moths, larvae and moth eggs is provided through air conditioning and scientific methods for sterilizing furs now being used in the storage vaults of A. A. John Danella & Sons, Utica, N. Y. Fur storage vaults are kept at a constant temperature of 39F by two Carrier refrigerating machines. This, combined with special treatment before the furs enter the air conditioned vaults, is said to guarantee freedom from all kinds of destructive insects.

Since air conditioning was installed in the vaults, Danella's have had no trouble with moths or other insects. Before the furs enter the vault, they are sterilized by a special method for destroying all moths, larvae and moth eggs. It is felt that the air conditioning, in addition to keeping the furs fresh throughout the hot summer, acts as a safeguard or check against any possible failure of the sterilization process.

The massive fur storage vault, for approximately 8,000 coats, maintained by the Danella firm is believed to be the largest in Central New York.

Appointment of SPAB and New Tax Among Month's News from Washington

GOVERNMENTAL action and preparations for defense continue to affect at an accelerated pace the heating, ventilating and air conditioning industry. Principal moves along these lines during the last 30 days can be summed up as follows:

1. President Roosevelt appointed a seven-man Supply Priorities and Allocation Board (SPAB), shuffling OPM's Division of Priorities and Office of Price Administration and Civilian Supply (OPACS), breaking a six-week jam in defense priorities and shifting the air conditioning and refrigerating industry's new industry committee from OPM's Purchases Division to Leon Henderson's Civilian Supply Division.

2. Congress passed the Revenue Bill which places a 10% excise tax on air conditioners, refrigerating apparatus, refrigerators and components.

3. Plans were announced to secure priority aid for 200,000 privately financed homes for defense workers in designated areas.

4. Two repair and maintenance orders were issued to facilitate installation of replacement parts in essential fields.

5. A Senate inquiry concluded there is no oil shortage, but conservation measures continue.

Dinegar Appointed

Under the President's order organizing SPAB, the industrial advisory committee for the air conditioning and refrigeration section of OPM lost its chairman almost before the ink had dried on announcements of committee personnel. C. W. Shearman was initially announced as the committee chairman, but under new plans completed September 26, the committee is to function under the chairmanship of H. A. Dinegar, of the Electrical Supplies and Consumers' Durable Goods branch of OPM's new Division of Civilian Supply.

Mr. Shearman, according to a letter mailed to members of the committee on September 26, will continue to serve as the industry's point of contact with OPM's Purchases Division, which is directly concerned with purchases for defense needs. Mr. Shearman will also continue to serve under James McPherson, assistant director of OPM's Equipment and Supplies Purchases Division.

A knowledge of the changes wrought in OPM and in OPAC by the creation of the new Supply Priorities and Allocation Board is necessary to understand the revised position of the air conditioning and refrigeration industry committee, and of the plumbing and heating industry committee to be formed soon with the assistance of Civilian Supply Division officials. Legal steps essential to the formation of the latter committee are nearing completion and during October an industry meeting to form the smaller industry committee will probably be called under the direction of John L. Haynes, chief of the lumber and building materials branch of the Civilian Supply Division. Mr. Haynes is in temporary charge of heating and ventilating matters within the division.

H. A. Dinegar who will function as chairman of the air conditioning and refrigeration industrial advisory committee.

The new SPAB resulting in the shuffling of OPM and OPACS duties was created by the President to formulate broad policies and general regulations for priorities and allocations. OPM will administer the program, it is announced by General Director William S. Knudsen, through six divisions: Civilian Supply, under Leon Henderson; Labor, under Sidney Hillman; Materials, under William Batt; Priorities, under Donald Nelson; Production, under W. H. Harrison, and Purchases, under Douglas L. MacKeachie.

SPAB is headed by Vice President Wallace, and includes the Secretary of War, Secretary of the Navy, William S. Knudsen, Sidney Hillman, Leon Henderson and Harry L. Hopkins. Donald Nelson acts as executive director of the board.

The seven men, subject to general policies enunciated by the President, periodically will fix the amount of materials to be allocated to military needs, defense-aid needs, economic warfare needs and total civilian needs. Under the new plan there will be brought around one table the agencies which have a major responsibility in distributing the available supply of materials in the United States.

The various industry committees previously existing in OPM and OPACS are now being consolidated, so that on questions of priorities, allocation and production, the varied industries of the country will have one unified contact with the Government, rather than a divided point. Some industry committees, like that of air conditioning and refrigeration, will move bodily into the new setup. Others will be shifted to take

advantage of the new SPAB lineup and others, like the yet unformed plumbing and heating committee, will start from scratch with the simplified OPM.

While the unexpected shift has held in abeyance some of the work of the air conditioning and refrigerating committee, several of the eight subcommittees have been active and early action through Committee Chairman Dinegar is in prospect. Appointment of Mr. Dinegar is said to meet with the entire approval of the industry, for he is well and favorably known in the air conditioning and refrigerating field.

For 18 years prior to accepting an appointment in Washington, Mr. Dinegar was directly associated with the industry, organizing Carrier Egypt, and being affiliated more recently with marine refrigeration activities of General Electric, in New York City.

The eight sub-committees functioning under Chairman Dinegar are as follows:

Industry Inventory Control and Analysis: J. A. Bentley, P. Y. Danley, Thos. Evans, G. E. Graff, E. A. Kleinschmidt, Raymond Starr, J. A. Strachan, and R. O. White.

Conservation, Production and Product Simplification: D. K. Banker, J. D. Harris, E. E. Harwood, S. E. Lauer, J. P. Rainbault, E. R. Wolfert, R. G. Wyld, and F. R. Zumbro.

Government Contacts, Proposed Purchases, Procedure Education: L. T. Brockbank, J. M. Fernald, John W. Hart, M. G. Munce, R. S. Read, B. J. Scholl, G. E. Wallis, and P. B. Zimmerman.

Ratings, Priorities, Allocations: Wm. C. Allen, R. H. Pearse, J. A. Bentley, F. H. Faust, C. V. Hill, Jr., M. W. Knight, L. C. Love, P. A. McKittrick, and A. B. Schellenberg.

Adaptation of Plant Machinery to Defense Work: J. W. Hatch, H. E. and/or R. W. Kritzer, W. G. Munce, Carl Ostling, T. S. Prendergast, Jerry Tyler, A. W. Wennerstrom, and John Wyllie, Jr.

Study of Federal Purchases as Related to This Industry: W. H. Aubrey, Frank Gleason, W. D. Keefe, M. M. Lawlor, E. T. Murphy, A. B. Newton, Wm. R. Ost, and H. R. Sewell.

Analysis of Government Specifications: J. H. Ashbaugh, Roger Dowling, Wm. Fogel, W. D. Jordan, F. D. Kirk, J. K. Knighton, R. M. McTurk, E. A. Vallee, M. B. Williston, and A. Knapp.

Committee of Miscellaneous Reference: J. A. Bentley, E. G. Biechler, F. H. Faust, Chas. J. Hall, F. J. Hood, Geo. S. Jones, Robert LeBaron, M. G. Munce, Frank R. Pierce, Frank K. Smith, R. J. Thompson, and C. E. Wilson.

Committees dealing with Ratings, Priorities and Allocations; Analysis of Government Specifications, and Miscellaneous Reference have been particularly active in Washington already, and with the new SPAB setup cleared, increased activity on the part of all subcommittees is anticipated.

If SPAB's breaking of the priority bottleneck on defense items may be taken as a criterion, the new setup will be greatly to the advantage of the industry. During the first week-end after being given his new assignment as Director of Priorities under SPAB, Donald Nelson and a crew of mail-order experts handled thousands of pieces of mail and broke a priority jam that had bottlenecked for weeks. New techniques were introduced to cut red tape and all ordinary applications or mail inquiries are now being handled within 48 hours.

Tax Ramifications Threaten

Offsetting the ray of hope seen on the Priorities horizon is the new Internal Revenue Code, Section 3405 of which has been amended to read as follows:

"There shall be imposed on the following articles (including in each case *parts or accessories therefor* sold on or in connection with the sale thereof) sold by the manufacturer, producer, or importer a tax equivalent to 10 per centum of the price for which so sold:

"(a) *Refrigerators, Etc.* — Refrigerators, beverage coolers, ice cream cabinets, water coolers, food and beverage display cases, food and beverage storage cabinets, ice making machines, and milk cooler cabinets, each such article having, or *being primarily designed for use with* a mechanical refrigerating unit operated by electricity, gas, kerosene or gasoline.

"(b) *Refrigeration Apparatus*—Compressors, condensers, evaporators, expansion units, absorbers, and controls, for, or *suitable for use as a part of*, or with, a refrigerating plant, refrigerating system, refrigerating equipment or unit, or any of the articles enumerated in subsection (a).

"(c) *Air-Conditioners*—Self-contained air-conditioning units.

"(d) *Components*—Cabinets, compressors, condensers, fans, blowers, heating coils, cooling coils, filters, humidifiers, and controls, for, or *suitable for use as a part of*, or with, any of the articles enumerated in subsection (c).

The new taxes went into effect October 1, with the result that tax experts representing air conditioning manufacturers, distributors and contractors are having some anxious moments over possible ramifications. The all-inclusive wording of the amendment, including such phrases as "suitable for use as a part of", raises the question of whether every item manufactured or used by the industry—every filter, valve, elbow, and control—is subject to the tax.

How far can the tax be passed along? What interpretation will be placed on incompleted contracts? These and many others are questions suggested by the new Code.

The safe answer, as suggested by Washington tax men, is *bill the tax on everything sold after October 1*, promising rebates if later interpretations reveal an overcharge.

Defense Housing Priorities

Of interest to all handlers of house heating and air conditioning equipment is the Defense Housing Priorities Plan which became effective September 22. Announced by Priorities Director Donald Nelson and worked out in collaboration with Charles F. Palmer, Defense Housing Coordinator, the new plan assures priority aid for 200,000 privately financed homes for

defense workers. Other arrangements have already been made granting priority assistance to 100,000 publicly financed homes.

The limiting feature of the new plan is that it is applicable only to houses valued at not more than $6000, in specified areas clearly identified with defense needs. Privately financed building in the higher price brackets must, under the new plan, stand in line for required materials, until defense requirements have been met.

A significant provision of the new priorities plan is that even for the 200,000 contemplated homes under the defense list, priorities for oil burners on the East coast are excluded. Following are the items for which priorities are granted.

1. Boilers—*Furnaces only for items noted below:*
   a. Boilers—ferrous metal with brass safety devices and cocks, limited to minimum practicable.
   b. Furnaces—ferrous metal with zinc coated casings, interliners and baffles for gravity furnaces and with zinc coated interliners where used in forced warm air furnaces.
   c. Breechings—ferrous metal non-metallic coated.
   d. Floor furnaces, space heaters, stoves and other similar heating devices, wherever practicable and where they may replace the above.
   e. Vents for heating equipment in demountable houses —ferrous metal, non-metallic coated.

2. Accessories—*consisting only of:*
   a. Pumps.
      (1) Water Circulators
      (2) Condensation
      (3) Vacuum
   b. Fans, Blowers and Motors—Centrifugal—Forced warm air systems only—Propeller—large exhaust on large multi-family units.
   c. Oil Storage Tanks, ferrous metal—non-metallic coated, size limited to minimum necessary, for example, not to exceed 275 gallons capacity for plants serving less than five families.
   d. Expansion tanks for hot water systems—ferrous metal, non-metallic coated.

3. Distribution Materials—*consisting only of:*
   a. Piping—ferrous metal, uncoated
   b. Fittings—Cast ferrous metal, uncoated
   c. Valves
      (1) Vent—ferrous metal wherever practicable, yellow brass elsewhere, no plating
      (2) Gate—(ditto)
      (3) Globe—(ditto)
      (4) Cocks—(ditto)
   d. Traps—central steam systems for multi-family dwellings only.
      (1) Boiler return
      (2) Blast
      (3) Bucket
      (4) Float and thermostatic.
   e. Ducts and connections.
      (1) Ferrous metal phosphate treated and painted or untreated
      (2) Bright tin
   f. Hangers and brackets.
      (1) Strap iron
      (2) Cast Iron

4. Radiators, Convectors and Registers—*only for items noted below:*
   a. Radiators and convectors of cast iron, without metal enclosure.
   b. Valves
      (1) Radiator, yellow brass unplated
      (2) Air Valves, yellow brass unplated
   c. Traps—Radiator, for multi-family dwellings only, yellow brass unplated.
   d. Registers and Grilles.
      (1) Stamped or cast ferrous metal
      (2) Fabricated steel optional for large units in floor.

5. Firing Equipment—*only for items listed below:*
   a. Oil, gas and coal burners
      NOTE: Oil burners eliminated from eastern seaboard area.

6. Control Equipment—*only for items listed below:*
   a. Damper Regulators
   b. Thermostats
   c. Pressure Controls
      (1) Pressure Reducing Valves—*Multi-family only*
      (2) Pressure stats
      (3) Pressure Relief Valves
   d. Relays

NOTE: Above items to be reduced to minimum and plating eliminated.

September in Washington brought the issuance of two repair and maintenance priority orders, one of direct and the other of indirect interest to the heating and ventilating industry. The first, designated as P-22, grants priority assistance for repair work to 20 essential industries. Heating and ventilating as an industry is not specifically mentioned, but those seeking to supply, repair, or maintenance parts to any of the 20 industries mentioned would find the ruling of value. Complete information about P-22 provisions, which supersede those given in the Repair and Maintenance Order announced in the August issue of HEATING AND VENTILATING, can be secured by writing to Priorities Division, Office of Production Management, Washington, D. C.

Of more direct interest to the industry is a repair, maintenance and supplies order issued September 17 by Director Nelson in an effort to help thousands of public utilities. Utilities which may use the new order are those engaged in one or more of the following services:

1. Supplying electric power directly or indirectly for general use by the public;

2. Supplying gas, natural or manufactured, directly or indirectly for general use by the public;

3. Supplying water directly or indirectly for general use by the public;

4. Public sanitation services, but not including manufactures of public sanitation products.

5. Supplying central steam heating directly or indirectly for general use by the public.

The order applies an A-10 rating to maintenance and repair materials and to operating supplies. Inquiries regarding this order, designated as Preference Rating Order No. P-46, should also be directed to OPM offices at Washington.

Oil Puzzle Unsolved

A Senatorial committee investigating the much-discussed oil shortage adjourned after lengthy hearings, announcing that the threatened shortage is a myth. Petroleum Coordinator Harold Ickes disagrees, but the fact that SPAB refused to grant priorities on the required 180,000 tons of steel plate and 190,000 tons of seamless steel tubing, indicates that other needs for defense overshadow the possibility of an oil shortage.

The shortage, however, still remains within the bounds of possibility, and there is no indication of a letup in efforts to conserve 10 to 15% on gasoline consumption as a precautionary measure.

Power Requirements and Efficiencies of Freon Compressors

By WILLIAM PARKERSON

IN two previous articles[1], a series of curves was presented for the quick and easy solution of ammonia compressor problems. Just as in the case of ammonia where a means was needed whereby the horsepower of a given compressor could be obtained without reference to its refrigerating capacity, so there exists a similar need for such information where compressors employing Freon-12 as the refrigerant are involved. This article, therefore, is an attempt to devise a set of charts from which the user may determine easily and with reasonable accuracy, for any given vertical, single-acting, reciprocating, compressor using Freon-12 as a refrigerant:

Brake horsepower required, without reference to the refrigerating capacity.

Refrigerating capacity, knowing the brake horsepower.

Refrigerating capacity, without reference to the brake horsepower.

While this is the primary purpose of the article, the subject of efficiencies emerges as a fascinating and important by-product of the original study and will be discussed in some detail later.

In order to dive immediately into the depths of the present subject, a typical problem is worked out, so as to illustrate the usefulness of the developed curves. Then, later, for the benefit of the more curious, the fundamentals underlying the preparation of the curves are presented.

Problem—Suppose a 4-cylinder Freon-12 compressor having a 4¼ inch bore and a 3 inch stroke is operating at 800 rpm against a suction pressure of 30 lb per square inch gauge and a head pressure of 140 lb per square inch gauge. We desire to know the brake horsepower required and the refrigerating capacity obtained.

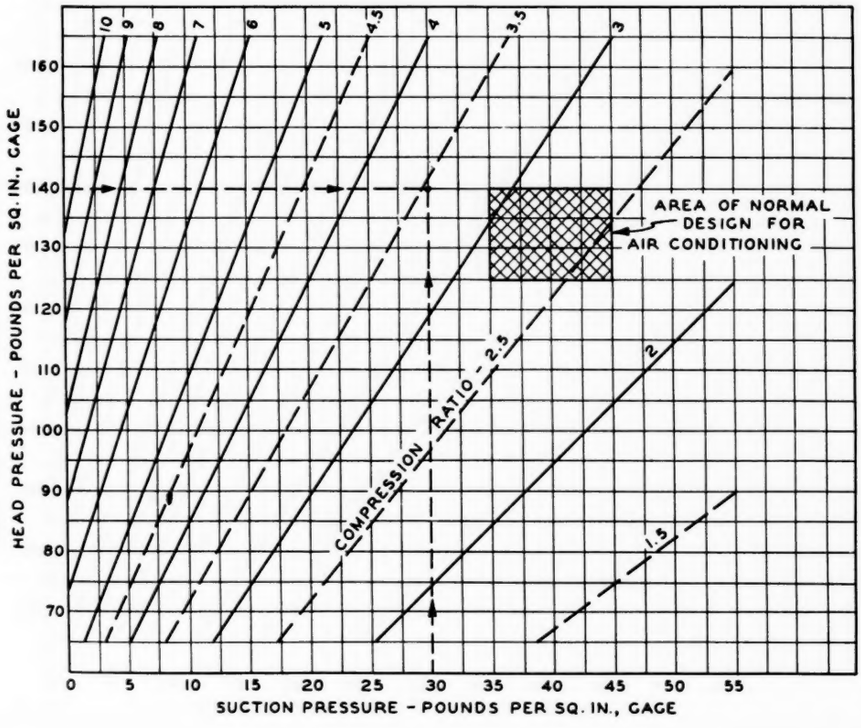
SOLUTION—From Fig. 1, we learn that the compression ratio, for the stated conditions, is 3.46

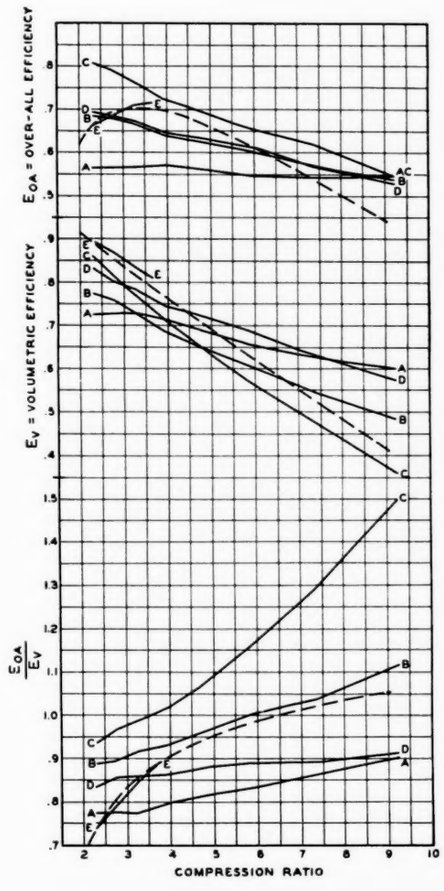
Now entering Fig. 3 from the extreme right at a compressor stroke of 3 inches and proceeding horizontally to the left until we reach a cylinder bore of 4¼ inches and thence vertically down to the base of the chart, we find a piston displacement of 2.46 cfm

[1]Power Requirements of Ammonia Compressors, HEATING AND VENTILATING, April, 1941, and Refrigerating Capacity of Ammonia Compressors, HEATING AND VENTILATING, July, 1941.

Fig. 1 (Below) Chart for determining the compression ratio knowing the suction and head pressures. Fig. 2 (Right) Efficiencies of Freon compressors. Plotting data calculated from manufacturers' data sheets for solid line curves. Dotted curves are theoretical.

NOTE: Curves A-A from manufacturer 1. Compressor displacement 1.074 cfm per cylinder per 100 rpm. Curves B-B from manufacturer 1. Compressor displacement 2.463 cfm per cylinder per 100 rpm. Curves C-C from manufacturer 1. Compressor displacement 8.181 cfm per cylinder per 100 rpm. Curves D-D from manufacturer 2. Compressor displacement 3.363 cfm per cylinder per 100 rpm. Curves E-E from manufacturer 3. Compressor displacement 2.909 cfm per cylinder per 100 rpm.





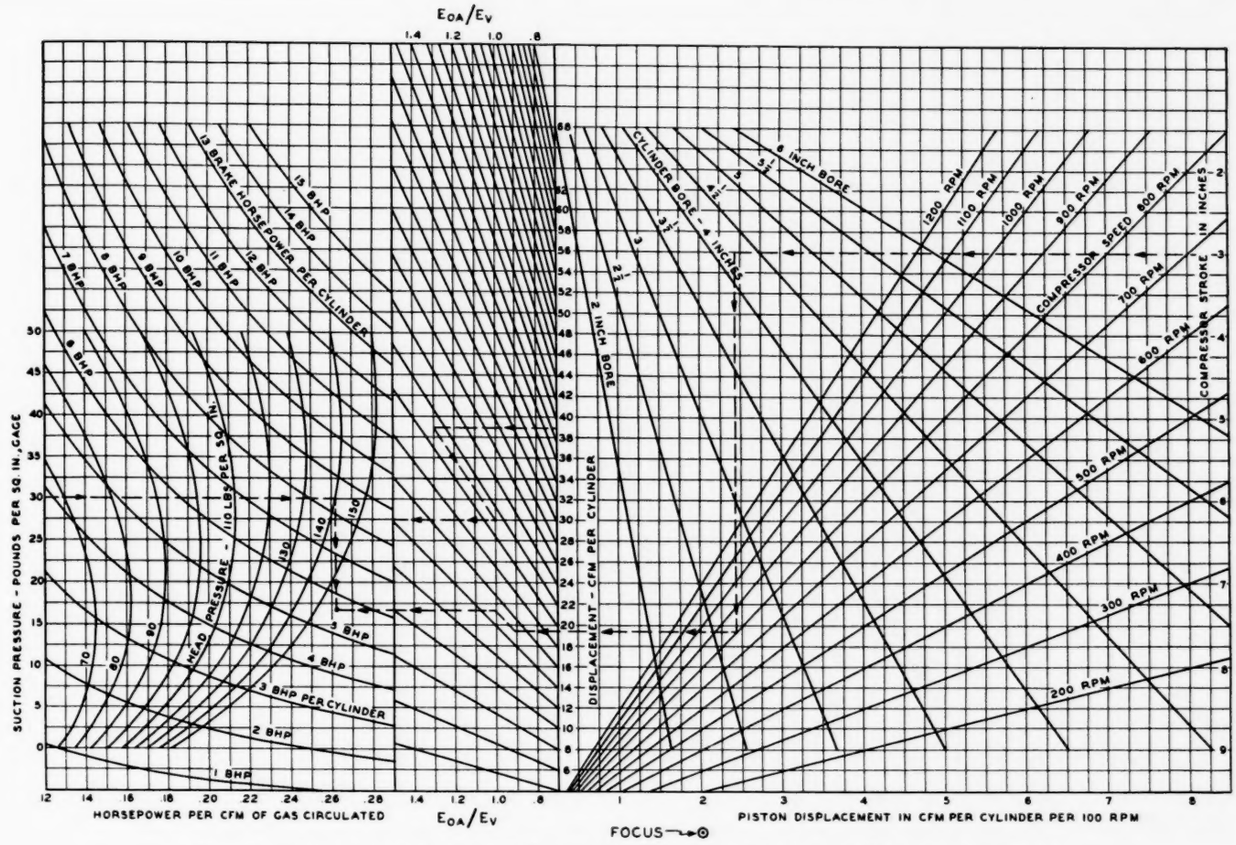


Fig. 3. Power requirements of Freon compressors. For use of this chart see text.

TABLE I.

Head Pressure in Lbs per Sq In Ga.	Heat Content of Liquid Freon in Btu per Lb.			Suction Pressure in Lb. per Sq. In. Ga.									
				0	5	10	15	20	25	30	35	40	50
				Cu. Ft. per Lb. of Freon Vapor									
				2.564	1.957	1.586	1.336	1.150	1.016	.909	.822	.751	.641
				Heat Content of Freon Vapor in Btu per Lb.									
				75.68	77.19	78.40	79.43	80.32	81.12	81.82	82.47	83.07	84.11
			p	.126	.138	.144	.145	.143	.138	.130	.120	.107	.077
70		23.88	q	9.900	7.342	5.818	4.810	4.075	3.550	3.138	2.806	2.538	2.129
			w	1.245	1.011	.837	.699	.583	.489	.407	.335	.273	.165
			p	.135	.149	.158	.162	.162	.159	.154	.146	.136	.110
80		25.61	q	10.242	7.588	6.009	4.965	4.274	3.661	3.234	2.891	2.614	2.191
			w	1.381	1.133	.949	.804	.693	.583	.497	.421	.355	.241
			p	.143	.160	.171	.177	.180	.179	.175	.169	.162	.140
90		27.24	q	10.586	7.836	6.200	5.120	4.333	3.771	3.331	2.977	2.690	2.254
			w	1.513	1.253	1.059	.906	.778	.674	.584	.504	.434	.316
			p	.151	.170	.183	.191	.196	.197	.195	.191	.185	.168
100		28.76	q	10.929	8.082	6.390	5.273	4.461	3.881	3.426	3.061	2.766	2.316
			w	1.645	1.371	1.167	1.007	.872	.763	.669	.586	.513	.388
			p	.158	.179	.194	.204	.210	.213	.214	.212	.207	.192
110		30.21	q	11.278	8.331	6.582	5.429	4.590	3.991	3.523	3.147	2.841	2.378
			w	1.776	1.489	1.275	1.108	.965	.852	.753	.665	.589	.458
			p	.164	.187	.204	.216	.224	.229	.231	.231	.228	.217
120		31.57	q	11.625	8.580	6.773	5.583	4.718	4.101	3.618	3.230	2.917	2.440
			w	1.906	1.605	1.381	1.205	1.057	.939	.835	.745	.665	.529
			p	.170	.195	.214	.227	.237	.243	.247	.248	.247	.239
130		32.89	q	11.984	8.836	6.970	5.741	4.849	4.213	3.716	3.316	2.993	2.503
			w	2.038	1.723	1.488	1.305	1.149	1.025	.918	.823	.740	.599
			p	.176	.202	.223	.238	.249	.257	.262	.265	.265	.260
140		34.16	q	12.348	9.094	7.168	5.901	4.982	4.326	3.814	3.402	3.070	2.566
			w	2.172	1.841	1.596	1.403	1.242	1.112	1.000	.901	.814	.668
			p	.181	.209	.231	.248	.261	.270	.277	.281	.282	.280
150		35.34	q	12.712	9.352	7.366	6.060	5.113	4.439	3.911	3.488	3.147	2.629
			w	2.305	1.958	1.703	1.503	1.333	1.199	1.082	.978	.888	.736

p = Theoretical horsepower per CFM of Freon vapor circulated. q = CFM of Freon vapor circulated per ton of refrigeration, w = Theoretical horsepower per ton of refrigeration.

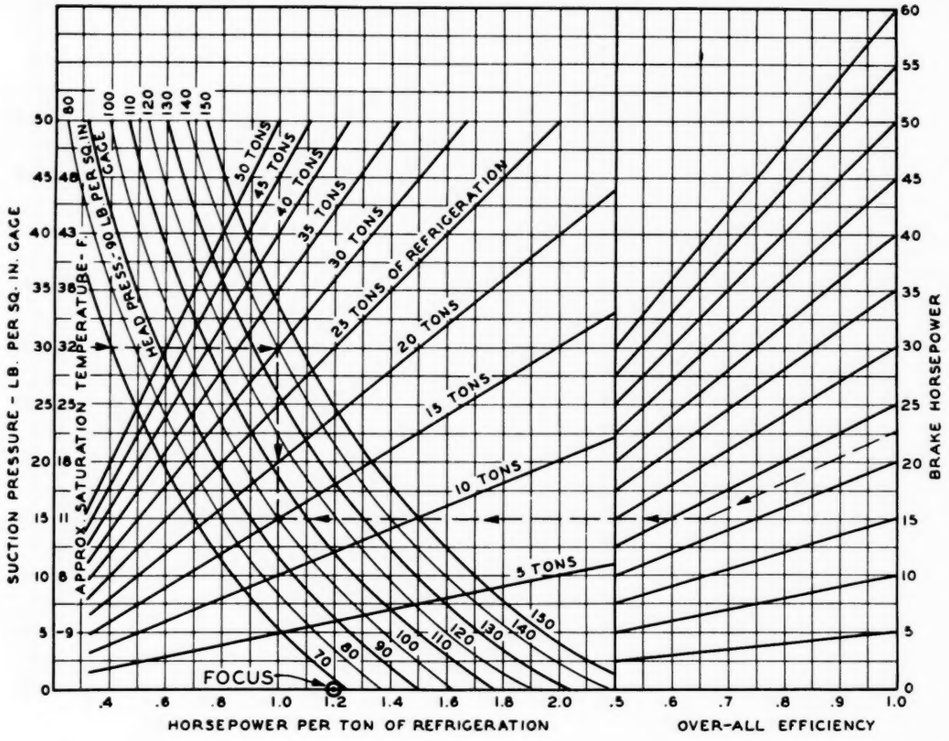


Fig. 4. Refrigerating capacity of Freon compressors. For use of this chart see text.

per cylinder per 100 rpm, which is an index or measure of the compressor or cylinder size. Using this information, together with the 3.46 compression ratio already secured from Fig. 1, we may exercise our judgment in selecting from Fig. 2 the following:

$$\frac{E_{OA}}{E_V} = .91,$$

$$E_V = .72, \text{ and } E_{OA} = .66,$$

where $\frac{E_{OA}}{E_V}$ is the efficiency ratio, E_V is the volumetric efficiency, and E_A is the overall efficiency.

Return, now, to Fig. 3 and find the point where the vertical line, previously established, intersects the 800 rpm diagonal. From this point, proceed horizontally to the left to an efficiency ratio of .91, thence along an imaginary line through the Focus to an efficiency ratio of 1.0. At this point establish a horizontal line extending to the left.

Now entering Fig. 3 from the extreme left at 30 lb per sq in gauge, proceed horizontally to the right until the curve for 140 lb per sq in head pressure is reached. At this point, drop a vertical, which will intersect the already established horizontal line at a point where may be read the value 5.67 brake horsepower per cylinder. Multiplying this value by 4 (the number of cylinders) gives a total brake horsepower of 22.68.

In Fig. 3, dotted lines higher up on the efficiency-ratio section of the chart illustrate how to proceed when an efficiency ratio greater than unity (1.3) is selected.

Having found the brake horsepower, it but remains for us to determine the refrigerating capacity. For this purpose, let us turn our attention to Fig. 4. Entering the chart at the extreme right at a brake horsepower of 22.7, proceed along an imaginary line through the Focus until an over-all efficiency of .66 is reached. Here, establish a horizontal line extending to the left. Now enter the chart from the extreme left at a suction pressure of 30 lb per sq in, proceed horizontally to the curve for 140 lb per sq in head pressure and then proceed vertically downward to the previously established horizontal line. At the point of intersection, read 15 tons of refrigeration.

This same result may be obtained in a more direct manner from Fig. 5, as follows: Entering from the extreme right-hand side at a piston displacement of 19.7 cfm per cylinder (which might have been read on Fig. 3, in passing), proceed along an imaginary line through the Focus to a volumetric efficiency of .72. At that point establish a horizontal line extending to the left. Now enter from the extreme left at a suction pressure of 30 lb per sq in and proceed horizontally to the intersection with the imaginary curve for 140 lb per sq in head pressure, lying midway between the curves for 130 lb per sq in and 150 lb per sq in. From this point drop vertically downward to intersect with the horizontal line previously established. At this point of intersection, read 3.75 tons per cylinder. Multiplying this result by 4 (the number of cylinders), we get a total refrigerating capacity of 15 tons.

Obviously, Fig. 4 would be especially serviceable where only brake horsepower, suction and discharge pressures were known.

It should be noted that in Figures 3, 4, and 5 special pains were taken to keep efficiencies separated from the body of the charts instead of working them into the results, as might have been done. This plan was followed in order that the value of the charts and the reliability of the results obtained might not rest wholly upon the writer's judgment in the matter of efficiencies. And this was done advisedly, as will be seen later.

Explanation of Charts

Fig. 1 is merely a graphical representation of the equation

$$R = P_1 \div P_s \quad \ldots\ldots (1)$$

where the coordinates are, for convenience, expressed in terms of the corresponding gauge pressures.

Fig. 2 will be discussed in detail later.

Fig. 3 is so similar to the corresponding chart for ammonia compressors which appeared in the April article and the theory underlying its preparation and use so nearly identical that it is not necessary to repeat it here.

Correspondingly, Fig. 4 varies in no wise, except as to refrigerant, from the chart in the July article.

Figure 5 is not unlike Fig. 4 in its design and application.

For these three charts, therefore, suffice it to say that Table I contains the plotting data for them all. In this table, line p contains plotting data for Fig. 3 and gives

$$p = \frac{THP}{Q} = \frac{144}{33{,}000} \times \frac{k}{k-1} \times P_s \left(R^{\frac{k-1}{k}} - 1\right) \quad \ldots\ldots(2)$$

where THP = theoretical horsepower, Q = cfm of Freon vapor circulated, p = theoretical horsepower per cfm of Freon circulated, k = ratio of specific heats for Freon 12 vapor = 1.145, P_s = suction pressure, lb per sq in absolute, and R = compression ratio = $\frac{P}{P}$

Line q contains plotting data for Fig. 5 and gives

$$q = \frac{O}{Tons} = \frac{200v}{H_v - H_L} \quad \ldots\ldots(3)$$

where q = cfm of Freon vapor circulated per ton of refrigeration, v = specific volume, cu ft per lb of suction vapor, H_v = heat content of saturated Freon vapor, Btu per lb, and H_L = heat content of liquid Freon 12, Btu per lb.

Line w contains plotting data for Fig. 4 and gives

$$w = \frac{THP}{Ton} = p \times q \quad \ldots\ldots(4)$$

where w = theoretical horsepower per ton of refrigeration.

In all of the calculations for Table I, it was assumed that both the liquid refrigerant and the suction vapor were at equilibrium temperatures. That is to say, that the liquid refrigerant approaching the expansion valve was not sub-cooled and the vapor approaching the compressor was not superheated. The figures in line p of Table I are not influenced by this assumption, but those in lines q and w are.

The value of k for Freon-12 vapor employed in the above calculations was taken from Table II, which gives data furnished by Kinetic Chemicals, Inc., on April 17, 1941, in response to a request for the best available information on the subject.

Efficiencies

The usefulness of Figures 3, 4, and 5 and the reliability of the results they produce, manifestly rest upon the faithfulness of the efficiencies employed. Obviously, therefore, it becomes the writer's responsibility to furnish the reader with an intelligent and usable guide for the exercise of good judgment in the selection of efficiencies. This is more difficult to do for Freon compressors than for ammonia compressors because, as explained by Moss[2]: "Ammonia machines are more nearly standard, as they have been made over a longer period of time, possibly by less manufacturers and the design is more nearly standard, which means that the horsepower for the various machines are more uniform." In view of these facts and in the hope of contributing to a clearer understanding of compressor performance, it was thought proper and fitting to undertake as thorough an analysis of Freon compressor efficiencies as the means at hand would permit. Thus emerges from the original study a deeper one of perhaps more far-reaching significance.

Data sheets on reciprocating Freon-12 compressors of three of the leading manufacturers show the number of cylinders, cylinder bore, and piston stroke for specific compressors. Each data sheet covering a specific compressor also shows, for various selected speeds, the power required and the refrigerating capacity obtained for numerous combinations of suction and discharge pressures. Having these data at hand, the apparent efficiencies may be calculated as follows:

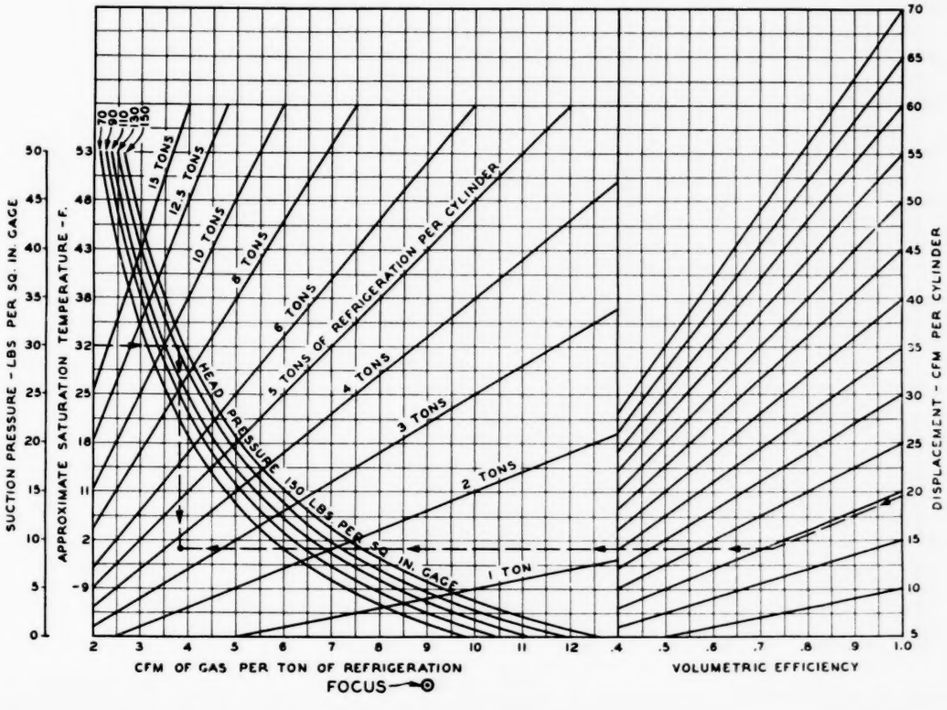


Fig. 5. Refrigerating capacity of Freon compressors. For use of this chart see text.

$$\frac{E_{CA}}{E_V} = \frac{pD}{BHP} \quad \ldots\ldots(5)$$

where BHP is the brake horsepower and D the cfm of piston displacement.

$$E_V = \frac{q \times Tons}{D} \quad \ldots\ldots(6)$$

$$= \frac{E_{OA} \times E_f}{E_f} \quad \ldots\ldots(7)$$

[2]In his article "Horsepower per Ton of Refrigeration: Ammonia vs. Freon," publication of the Southern Ice Manufacturers' Association, April, 1941.

TABLE II.

SPECIFIC HEAT "FREON-12" VAPOR

LB PER SQ IN, GAGE	TEMP., F	C_p	C_v	$\frac{C_p}{C_v}$
.6	— 20	.1340	.1157	1.158
9.2	0	.1366	.1183	1.155
21.1	20	.1391	.1210	1.150
37.0	40	.1417	.1236	1.146
57.7	60	.1443	.1263	1.142
84.1	80	.1468	.1289	1.139
116.9	100	.1494	.1315	1.136
157.1	120	.1520	.1342	1.132
			Average	1.145

$k = C_p \div C_v = 1.145$

Derivation of equation (5) was made clear in the previously mentioned article which appeared in the April number. Now, p may be calculated by substituting the known conditions in equation (2), or its value may be read from Table I.

$$\text{Obviously } D = \frac{\pi B^2 \times S \times RPM}{4 \times 1728} \times n \quad \ldots\ldots\ldots\ldots (8)$$

where B is the cylinder bore, inches, S is the piston stroke in inches, and n is the number of compressor cylinders. BHP is read from the data sheets, as already pointed out.

Equation (6) is self-evident. Equation (3), or Table I, gives the value of q for the known conditions. Multiplying this value by the tons of refrigeration as read from the data sheets, gives the CFM of suction vapor that must be in circulation. Then, by definition, E_v is the ratio of the gas actually circulated to the piston displacement.

Equation (7) requires no explanation.

In order to produce an intelligent guide for the selection of efficiencies, it is necessary to correlate the efficiencies to any other variable or variables upon which the efficiency values may depend. At the same time, it is necessary to discover, if possible, those variables which exert only a negligible influence on the values of the efficiencies. These requirements lead us to inquire into the degree of variation of the efficiencies with changing operating conditions. Table III displays the results of such an inquiry conducted by a simple method. The method is to vary only one operating condition at a time and observe the effect of this single change on the efficiencies. As a measure of the sensitiveness of the efficiencies to changes in the various operating conditions, the figures in lines 12, 14, and 16 are submitted. For example, in comparing case 1 with case 2, no change is made except in the speed of the compressor. The volumetric efficiency in case 1 is .703 and the volumetric efficiency in case 2 is .742. Therefore, the percent variation from the mean value of E_v for this particular comparison is

$$\frac{.742 - .703}{.742 + .703} \times 100 = 2.7\%$$

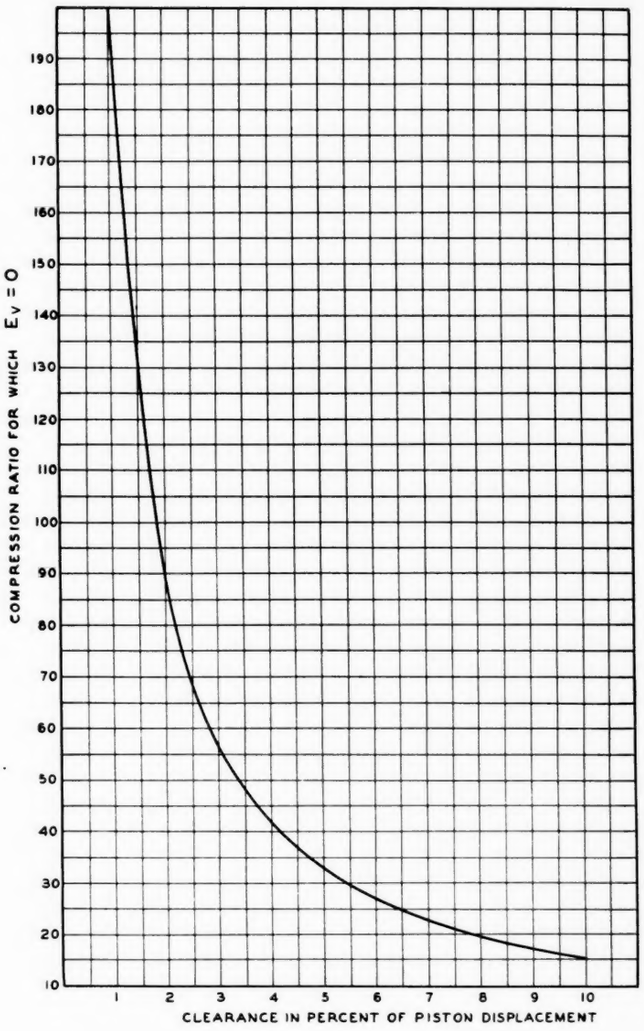


Fig. 6. Relation between clearance and compression ratio when $E_v = 0$.

All other figures in lines 12, 14, and 16 were obtained in a similar manner.

A close inspection of Table III, leads to the following conclusions:

1. Efficiencies are comparatively unresponsive to changes in speed. Case comparisons 1-2 and 2-7.
2. Efficiencies are quite sensitive to changes in size and design. Case comparison 4-3.
3. Efficiencies are practically independent of changes in operating pressures, provided the compression ratio is held constant. Case comparison 5-2.
4. Efficiencies are very sensitive to changes in compression ratio. Case comparison 6-2.
5. Efficiencies vary with different manufacturers (which would seem to mean "design"), but not exceedingly so, when size, as indicated by line 3, is held approximately constant. Case comparisons 7-10, 8-10, and 9-10.

From the above considerations, it was decided to correlate efficiencies to compression ratio for different sizes of compressors of the same manufacturer and for different manufacturers of approximately the same size compressors. This correlation is shown in Fig. 2, where no attempt was made to run a smooth curve

through the plotted points. Instead, straight lines were drawn between points, in order to portray as faithfully as possible the information deduced from the manufacturers' data sheets. Notice that the curves are lacking in agreement as to both trend and shape.

The writer is fully mindful of the fact that not every figure on data sheets of manufacturers is a direct "laboratory-research" result. It is common practice to interpolate between, and even extrapolate beyond, certain test "bench-marks." Moreover, caution requires that the data be made to err slightly on the safe side from the manufacturer's view-point. Nevertheless, these data must be sufficiently reliable so that the air-conditioning and refrigeration contractor can depend upon them and so that the manufacturer can back them up, as he needs must do. Therefore, the writer feels that, in presenting Fig. 2, he has discharged his obligation to furnish an intelligent guide for the selection of efficiencies.

Fig. 6, a graph of the equation,

$$R = \left(\frac{1}{C} + 1\right)^{1.145}$$

where R is the compression ratio and C the clearance or ratio of clearance volume to piston displacement, shows the compression ratios for which the volumetric efficiency is zero at various clearances. Notice that for the dotted line for E_v on Fig 2, for which $C = .10$, E_v becomes zero when $R = 15.6$.

It can be shown that $E = 1 - C\,(R^{\frac{1}{k}} - 1)$. This equation was used in plotting the dotted line for E_v in Fig. 2, and a value of $C = .10$ was employed. This value was used, not because of any notion on the part of the writer that clearances of the magnitude of 10% are commonly to be found in practice, but because, when $C = .10$, the dotted line whose shape and trend are thus determined, assumes, as nearly as possible, a median position among the curves deduced from manufacturers' data sheets.

Efficiency Ratio

In an earlier article by the writer, the efficiency ratio $\frac{E_{OA}}{E_v}$ was termed Compressor Efficiency. This is now felt to have been a mistake. It is unquestionably far more proper to treat this quantity as a ratio, in view of the fact that E_v is not really a true efficiency in the pure sense of the word. Moreover, under certain conditions, the Efficiency Ratio rises above unity.

In plotting the dotted line for $\frac{E_{OA}}{E_v}$ in Fig. 2, the following equation was used:

$$\frac{E_{OA}}{E_v} = 10\left(R^{.0321} - 1\right)\left(\frac{4}{R} + 1\right) \qquad \text{.....(9)}$$

This equation is purely empirical and bears no relation to any theoretical considerations except that the curve must pass through zero when R is unity and increase indefinitely as R increases. In addition to the above, equation (9) was designed to produce a dotted curve which would assume, as nearly as possible, a median position among the "manufacturers'-data-sheet" curves.

Over-All Efficiency

When values were read from the dotted line for E_v and multiplied by corresponding values read from the dotted line for $\frac{E_{OA}}{E_v}$, plotting data for the E_{OA} dotted line were secured.

Since the curve for over-all efficiency has two zero points, it obviously rises to a peak and then descends, as the dotted line is seen to do. In other words, it would appear that for each compressor, there is some one compression ratio for which the over-all efficiency is a maximum. If this is a fact (and the writer believes a hitherto unrecognized fact) then it would seem that an important factor in the design and rating of refrigeration compressors may have been overlooked.

The writer wishes to express his grateful appreciation to George A. Mills for his helpful and encouraging criticisms and comments.

TABLE III.

1	Case No.	1	2	3	4	5	6	7	8	9	10
2	Bore and Stroke	4¼ × 3	4¼ × 3	3 × 2⅝	6 × 5	4¼ × 3	4¼ × 3	4¼ × 3	4 × 4⅝	4 × 4	—
3	Displacement Cfm per Cyl. per 100 rpm	2.463	2.463	1.074	8.181	2.463	2.463	2.463	3.363	2.909	2.912
4	Rpm	800	340	450	450	340	340	550	545	560	552
5	Head Press. Lb per Sq In Ga.	140.1	140.1	140.1	140.1	87.0	140.1	140.1	140.1	140.1	140.1
6	Suct. Press. Lbs per Sq In Ga.	37.0	37.0	37.0	37.0	19.4	2.5	37.0	37.0	37.0	37.0
7	Compression Ratio	3	3	3	3	3	9	3	3	3	3
8	Manufacturer	No. 1	No. 1	No. 1	No. 1	No. 1	No. 1	No. 1	No. 2	No. 3	Avg. 7,8,9
9	Compared with Case No.	2	7	—	3	2	2	10	10	10	—
10	Only Change	Speed	Speed	—	Size Design	Optg. Press	Comp. Ratio	Mfgr. Des.	Mfgr. Des.	Mfgr. Des.	—
11	$\frac{E_{OA}}{E_V}$	.894	.916	.784	.984	.918	1.111	.916	.860	.823	.866
12	% Variation from Mean	1.22	0	—	11.31	.11	9.62	5.77	.69	4.97	—
13	E_V	.703	.742	.705	.793	.755	.477	.742	.792	.867	.800
14	% Variation from Mean	2.70	0	—	5.87	.87	21.74	7.25	1.00	8.38	—
15	E_{OA}	.648	.680	.553	.780	.693	.530	.680	.681	.714	.692
16	% Variation from Mean	2.41	0	—	17.03	.95	12.40	1.73	1.59	3.18	—

AIR CONDITIONING FOR DEFENSE

Army Bomber Plants

in Fort Worth and Tulsa, with 7000 tons of air conditioning in each, are insulated with 406 carloads of glass insulation to reduce cooling load. Vapor seal provided. Heating by combination oil and gas boilers.

Projects designed by THE AUSTIN CO.

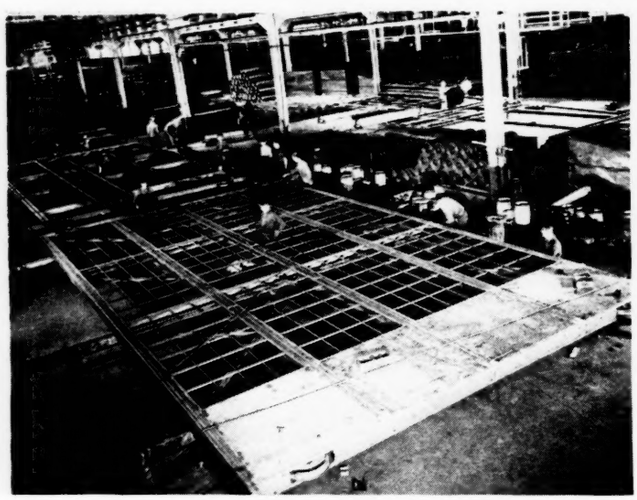
AN ingenious combination of glass fiber and prefabricated steel panels to form a new type of shatter-proof, non-combustible side wall and roof construction is being used to insure insulation and acoustical control for working efficiency in the twin 4000-foot long Army bomber assembly plants being erected at Fort Worth, Tex., and Tulsa, Okla. Engineers of The Austin Company, who designed both plants, evolved the combination which utilizes products developed by Truscon Steel Company and Owens-Corning Fiberglas Corporation in an entirely new approach to the task of insulating vast factory areas for economical year-round air-conditioning.

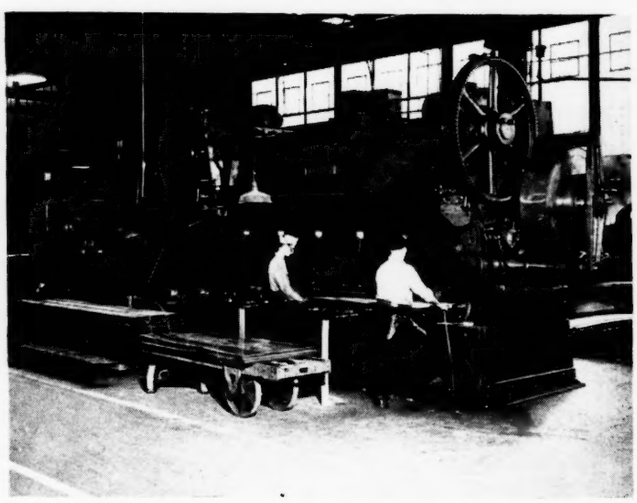
With a total of 406 carloads of Fiberglas required for these jobs they will probably contain more glass in their windowless steel side walls and roof than the largest daylight factories ever built. By blanketing all interiors with several layers of these materials, which are calculated to eliminate or control all condensation and to reduce heat loss and gain to a practical minimum, the cooling and heating loads have been substantially reduced.

Each plant requires 7000 tons of refrigeration, enough to operate more than a quarter million large household refrigerators, to cool the space where a total of 30,000 men will soon be assembling four-engined bombers on moving assembly lines.

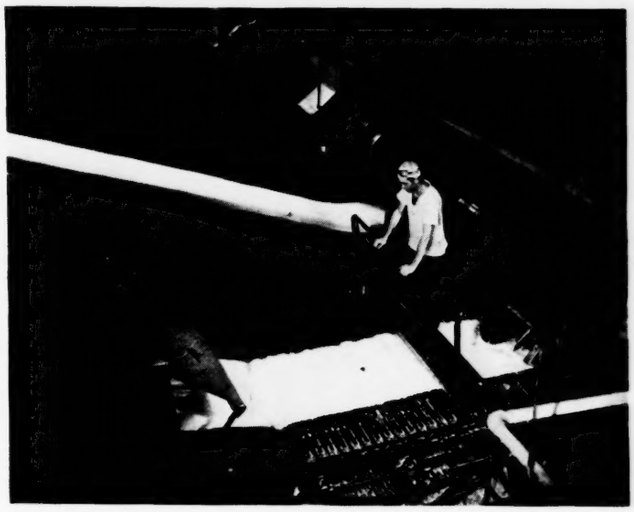
At the Fort Worth plant, which will be operated by Consolidated Aircraft Co., alternate layers of Fiberglas and vapor seal paper, held together with asphalt, are being combined with steel channels, roofing sections and metal lath to give the walls and roofs of all buildings maximum strength and the highest obtainable acoustical, insulating and light-reflecting qualities. The Tulsa plant, to be operated by Douglas Aircraft Co., is of similar design.

The assembly buildings at both plants and a majority of the auxiliary structures at each plant have an over-all height of 65 ft. A 13 in. curtain wall of face brick and acoustic block, which is being specially reinforced with trussed rods to make it shatter-proof, rises to a height of 12 ft around the base of all buildings. The special insulated metal wall extends from that point to the roof. Fiberglas insulation board continues down to the base of all walls through the masonry in order to insure absolute control of condensation. All doors, 40 ft high and from 150 to 200 ft wide, will be insulated in a manner comparable with the side walls, with weatherproofing at jambs in keep-





Assembling one leaf of a huge Truscon vertical lift type steel hangar door at Youngstown for the bomber plants. Eighteen 200-ft doors which will be installed in units 100 ft wide, and four 150-ft single unit doors of this type will be required for the two plants. (Right) The ribbed exterior facing panels for shatter-proof side walls of the huge air-conditioned bomber plants are being fabricated from 18-gauge steel in the Youngstown plant of The Truscon Steel Company.



Unrolling glass wool which blankets roofs and walls. Runner channels, which are welded to the steel purlins 33 in. on centers, support the 3/8 in. ribbed expanded metal lath on which is spread a thin light-reflecting mat of Fiberglas and a 3 in. blanket of white Fiberglas, which affords sound absorption, fire-resistance and the proper degree of insulation. This, in turn, is covered by a metal deck consisting of 18-gauge 1½ in. deep Ferroboard, some of which is already in place in the foreground. (Right) These machines in the Newark, Ohio, plant of Owens-Corning Fiberglas Corp. are producing white Fiberglas wool and semi-rigid Fiberglas insulating board for the windowless bomber plants. Walls and roofs of the two plants will use a total of 5,573,000 sq ft of the white wool which is shown on a conveyor in the foreground.

ing with the requirements of air-conditioned buildings.

Roof and wall construction will be uniform in all buildings at each site, including a two-story office building, a maintenance shop and boiler house, all of which adjoin the 4000-ft long assembly building, and a paint shop, hangar and cafeteria buildings, which are separate structures.

By blanketing the interior walls of each structure with the glass insulation, the engineers have not only provided for insulation antl absorption of between 60 and 75% of all factory and office noises, but have also obtained a light-reflecting surface which will maintain brightness at a high level.

Each plant will have three combination gas and oil fired boilers furnishing a total of 300,000 lb of steam per hour at 225 lb pressure; three air-compressors each with a capacity of 1500 cfm; and three fire pumps capable of delivering a total of 4500 gpm to the plant sprinkler systems and fire stations on various parts of the site.

Ultraviolet Lamps Sterilize Air in Large Brewery

The first complete application of ultraviolet lamps to safeguard the production of beer has been made at the Duquesne Brewing Company, Pittsburgh, Pennsylvania. Elimination of extraneous air-borne micro-organisms which may be present in the wort-cooling room, fermenting tanks, and bottling works is accomplished by ultraviolet rays from Westinghouse Sterilamps. Essentially these units are long, slender, tubular, lamps made of high transmission glass and containing a very small quantity of mercury. Most of the radiation emanating from the mercury vapor is in the bactericidal region of the spectrum providing a most efficient generation of radiation effective in killing the undesirable bacteria usually present in the air.

The various ingredients going to make up beer are first boiled in a vat after which it is called wort. This is cooled from about 200F down to 50F by passing the liquid over cooled copper pipes through which a refrigerant is circulated. During this process, the wort may be exposed to wild yeast spores floating in the air which can be effectively removed by ultraviolet irradiations. If these yeast spores were not eliminated, secondary fermentations might be set up affecting the flavor uniformity of the brew and, in severe cases, might cause complete spoilage.

After cooling, the wort is piped to fermenting tanks where it remains until fermentation is completed. The liquid is then drawn off into aging vats and is finally bottled. A portable unit consisting of six 30 in. Sterilamps is inserted in an opening at the side of the fermenting tank and is permitted to burn until the tank is ready for use or until enough cooled wort is available to fill the tank. This ensures elimination of practically all micro-organisms in the air and on the inside surface of the tanks. The minimum radiation time is about one-half hour but may run as high as several hours.

In the bottling department a conveyor carries the bottles from the soaker (water and sterilizing machine) to the filling and capping machines. Over the top, as close as possible to the open ends of the bottles, is mounted an inverted U-shaped hood of stainless steel. Continuous line of Sterilamps under the hood prevents any air-borne bacteria from contaminating the bottles before they are filled. The hood, in addition to shielding the eyes of the workmen from direct radiation, also prevents dust and dirt from getting into the bottles as they pass on to the automatic filling machine

A Short Cut Heat Loss Formula for Residential Heating

By FRED CARNES

The author develops a very simple formula for determining the amount of steam radiator surface needed for houses. In many cases it can be used without correction, but even when adjustments are necessary for other special conditions, the corrections are quite simple.

I HAVE long wondered what reasoning is behind the assumption that a room would have a certain number of air changes per hour, and still do not know. I do know, however, a probable reason why, in ordinary houses, the results of such an assumption are so good.

It is safe to say that in the volume method, as ordinarily used, no account is taken of upstairs ceilings. Old heating men claim that in residences the upstairs ceilings are taken care of by warm air rising from downstairs. This seems to be so. In fact, I have several times seen inexperienced computers add the ceiling loss for upstairs rooms with the result that the upstairs is overheated.

What I believe really is the case is explained as follows:

If we take an upstairs room of width w, length l, a ceiling height of 8½ ft, and a heat transmission coefficient of 0.62 for lath and plastered ceiling and assume, as is common practice, that the attic temperature is a mean between inside and outside, we get, with a temperature difference of 80F between inside and outside and with 40F between ceiling and attic, a heat transmission loss through the ceiling equal to $wl \times .62 \times 40 = 24.8wl$. The heat loss in one air change is $w \times l \times 8.5 \times .018 \times 80 = 12.3wl$.

That is, the upstairs ceiling loss is almost exactly twice that of one air change.

We know, of course, that in an ordinary house with the inside doors open, as they usually are, warm air rises from downstairs to upstairs, replacing cooler air that drops down the stairs and is then heated by the downstairs radiators. However, we do not know the exact quantity of this air or its heat content. But since past experience shows that where upstairs and downstairs rooms are figured the same way, with calculations for upstairs ceilings omitted, the house heats fairly evenly, it seems to be a fair assumption to consider that half the upstairs ceiling is taken care of by the upstairs radiators and half by those downstairs. That is, the heat for one air change upstairs and one downstairs takes care of the upstairs ceilings.[1]

In rooms where one air change is used there is, therefore, nothing left for air leakage. Such rooms ordinarily have only one exposed wall and do not have many windows as there is no room for them. The air leakage is, therefore, comparatively low. In rooms with two or more exposed walls, with one and a half or two air changes used and more windows, there is an excess of one-half and one air change respectively to take care of air leakage. Ordinarily, it seems to do this very well.

It, therefore, appears to me that the old-fashioned volume method will give better results in ordinary houses than will the standard method if followed blindly without judgment, since the latter method, so far as I can determine, considers the heat losses of the upstairs ceilings to be part of those of their respective rooms.[2]

In bungalows and multi-flat and similar buildings where no air rises from floors below, conditions are reversed, and the volume method tends to overheat the downstairs and underheat the upstairs in multi-flat buildings, and to underheat bungalows. Therefore, in such cases the standard method is better.

Modifying the Standard Method

We believe we have shown that: (1) the standard crack method will result in overheating the upstairs and underheating the downstairs; (2) to make the crack method heat evenly, one-half the ceiling should be used for both upstairs and downstairs rooms instead of all the ceiling upstairs and none downstairs; (3) one air change gives enough heat to take care of half the ceiling with none left over for air leakage; (4) the additional one-half or one air change where a total of one and a half or two is used may be considered as applying to air leakage but may or may not be correct for it.

It is evident, therefore, that in ordinary houses with uninsulated upstairs ceilings, if correct figures are used for air leakage and one-half the ceiling is considered as exposed to the temperature of the attic for both upstairs and downstairs rooms, more accurate results will be obtained by the crack method than by the old-fashioned volume method.

It also appears that if the upstairs ceiling is insulated, so as to have a transmission coefficient of

[1] Our friend "the judgment of the engineer" must be used here in some cases. Where an upstairs room, as sometimes happens, is cut off from the rest of the house so that no heated air from downstairs can possibly reach it, it is of course necessary to include all the ceiling in the heat loss calculations for such a room.

[2] I have seen houses where upstairs ceiling heat losses were figured as all belonging to upstairs rooms that did heat fairly evenly. Such houses, however, were heated by forced warm air. With this method, since the air pressure is so much higher and the air so much warmer near the furnace than at the ends of long runs, even with dampers near the registers closed off, there is often enough air getting past them to give sufficient heat, or even too much, to the downstairs. If such is the case, it must be accredited either to natural characteristics or poor design of the duct work, rather than to correct heat loss calculations.

about 0.20 or less, instead of 0.50 or 0.62, enough heat to take care of it will be obtained from the downstairs radiators, with no allowance needed upstairs. For no matter how much the upstairs ceiling is insulated, it can not prevent the warm air rising from downstairs and can have no appreciable effect on the downstairs radiation.[3]

Crack Method Formulas

If we wish to obtain a simple formula, one way to do it is first to select a good set of average conditions, and then try them out. As we go along we may find that a change in assumed conditions may make the formula simpler. In any case, it is easy, after we have worked out the results from such assumed conditions, to alter them if the actual conditions are different.

Thus, the formula derived here is based on a temperature difference between inside and outside air of 80F, which, as it happens, is as good to use as any. After the result from this formula is obtained additions or deductions can be made for other design temperatures.

What follows, then, shows how simple the crack method can be made.

Wall Heat Loss

Text and handbooks have as many as thirteen pages giving transmission coefficients for variously constructed walls, ceilings, floors, and roofs. How many of them are ordinarily used? I am sure it is very few. Certainly few are used for houses. Among the reasons for this are:

(1) In old houses we may not be able to tell what the construction of the wall is;

(2) It is a lot of trouble to use a different transmission coefficient for each type of wall, and a single calculation cannot be made without having a handbook with you, since nobody could remember all the coefficients;

(3) Even if we do know the construction of the wall and obtain from the handbook the proper *average* coefficient for it, we can not be sure that it will be the proper one several years hence. Insulation may have absorbed moisture or sagged or otherwise altered, and so on.

An inspection of coefficients shows that 0.25 is a good average transmission coefficient for ordinary house walls.

The amount of steam radiation r_w required to take care of such a wall, for an 80F temperature difference, is therefore

$$r_w = \frac{W_n \times 80 \times .25}{240} = .083\ W_n \text{ sq ft, where } W_n$$

is the net exposed wall area.

[3]Extravagant claims are sometimes made as to the amount of heat and fuel saved by insulating top floor ceilings in existing houses with existing heating systems. If a thermostat downstairs governs the operation of the heating system, the effect of such insulation will be largely not a saving in fuel but an overheating of the upstairs rooms. Fuel can be reduced only by reducing the amount of upstairs radiation. This note naturally applies only to ordinary houses.

Window Transmitted Loss

Coefficients U of 1.13, .45, and .281 for single, double, and triple glass, respectively, are commonly used for windows. Not only are double and triple glass windows very rare, but in any house that had them there would be no desire to have the radiation figured too closely. Even if double windows consist of an ordinary window plus a storm sash it does not seem wise to reduce the radiation on account of the latter, for often the storm sash may not be put up, particularly in bedrooms, where it would prevent the windows being opened. Therefore 1.13 will be used here.

Similarly with doors, the various values of U depend on the thickness of the door. Since, however, it is stated that 1.13 is sufficiently accurate to use for doors containing thin wood panels, and since door loss in general is more or less a guess, as no one knows how many times during a day they will be opened and closed, it seems wise to allow 1.13 for all doors, the same as for windows.

The amount of steam radiation r_g required to take care of the heat transmission through the windows and doors is therefore, for our 80F,

$$r_g = \frac{G \times 1.13 \times 80}{240} = .377\ G \text{ sq ft, where G is}$$

the window and door, or glass area.

Infiltration Loss

Here there is a lot of guessing to do. We must decide:

(1) The kind of windows to consider, whether ordinary wood double-hung sash, or something special such as metal sashes. Here we will assume ordinary wooden sashes.

(2) Proper wind velocity. Use the average winter wind in your locality as given by the Weather Bureau. In most places this is about 10 miles per hour, so we may as well start off with that. It is easy to correct for other wind velocities as will be shown later.

(3) Fit of the windows. Since the air leakage for poorly fitted windows is about three times that for average windows a decision must be made here. However, if we are going to figure that every window is poorly fitted we might as well go a step further and consider that each one has a pane of glass out and make a real job of it. Therefore, here we will say the windows are average.

(4) Should we allow for weatherstrips, if any? If we say, as in (3), that the windows are average, when the time comes that they are not, due to shrinkage, and we have not allowed for weatherstrips, we have a factor of safety. Besides, as time goes on, the material in the weatherstrips, such as rubber or felt may lose its resiliency, making it ineffective. It seems wise, therefore, if we use average windows, not to make any allowance for weatherstripping.

(5) Length of crack to use. This, as explained before, is that around the window sashes on the side of the room having the most crack, but not less than half the total crack of the room.

Thus we have decided, for the present, to consider average non-weatherstripped wood-sash windows with

a 10 miles per hour wind velocity. The handbook gives 21.4 as the number of cubic feet of air leakage per hour for these conditions.[4] The amount of radiation r_i to take care of air leakage for our 80F is, therefore:

$$r_i = \frac{L \times 21.4 \times .018 \times 80}{240} = .1284\ L,$$

where L is the length of crack in feet.

Ceiling Heat Loss

We showed before that in ordinary houses it seemed reasonable to say that one half the ceiling area should be used for both upstairs and downstairs rooms. We could use length times width just as well, which would make figuring easier in upstairs rooms with sloping walls. If .62 is used as a transmission coefficient for ordinary ceilings exposed to the attic temperature, with a mean temperature difference of 40F, we get the amount of steam radiation $r_{c/2}$ to take care of the ceiling is

$$r_{c/2} = \frac{w \times l \times .62 \times 80}{2 \times 240} = \frac{wl}{2} \times .103$$

For bungalow ceilings and those of the top floors of multiflat or similar buildings this becomes wl × .103. For lower floors of multiflat buildings it can be omitted.[5]

Simplification of Crack Method

Our formula for total radiation R under the assumed condition is

$$R = r_w + r_g + r_i + r_{c/2} =$$

$$.083W_n + .377G + .1284L + .103\,\frac{wl}{2} \qquad (1)$$

This is certainly not simple. Let's see what we can do with it.

Since the four terms of formula (1) apparently do not have much relation to each other, if we should simplify by, for example, using .1 instead of .083, or .4 instead of .377, we should not expect to get exactly the same results as with the exact formula. The total would be either too high or too low. Let us see, though, how much it could be too high or too low and still be near enough.

I believe that if three people figured the radiation for a house, one getting 420 sq ft, the second, 400 sq ft, and the third, 380 sq ft, they would be considered fairly close. That is, assuming 400 to be correct, the 420 would be 5% too high and the 380, 5% too low, all of them, however, being near enough for practical purposes.

If we assume that formula (1) is correct as it stands, and we can simplify it in such a way that with far less work we can get a total result within 5% up or down from the (1) result, we will not be unreasonably off. We can, however, get much closer than that. For if we can simplify the four terms so that any percent up in one is balanced by a similar percent down in another the total result can be made very close to the exact figure.

First Simplification

One way the formula (1) can be simplified is fairly obvious from a casual inspection. If we make the term $\frac{wl}{2} \times .103$, simply $\frac{½wl}{10}$, it would be 3% too low; then, provided that the value of this term is less than 1/3 of the total radiation, as is probable, the total would be less than 1% too low. Considering that our assumption of a 40F attic temperature was to a large extent a guess and that probably the attic will be used for storage and have some kind of flooring on it, thus reducing heat transmission, we can consider a result of 1% too low as very close figuring. Therefore r_i becomes $\frac{½wl}{10}$.

Attic Temperatures

The standard handbook states that while a mean between room and outside temperatures is accurate enough to use for the attic where rooms below have an ordinary ceiling, it is not accurate enough where ceilings are insulated. This, of course, is so because the attic is heated by transmission through the ceiling, and if the amount of heat so supplied is cut off by insulation, the attic will be cooler. Listed below are four ways to arrive at the attic temperature where ceilings are insulated:

(1) Guess at it.

(2) Work it out by the *Guide* formula:

$$t_a = \frac{A_c U_c t_i + t_o(A_r U_r + A_w U_w + A_g U_g)}{A_r U_r + A_w U_w + A_g U_g + A_c U_c}$$

where t_a is the attic temperature, A_c, A_r, A_w, and A_g are the areas of ceiling, roof, vertical wall and glass, respectively, U_c, U_r, U_w and U_g the coefficients for these areas, t_i the temperature near top floor ceiling and t_o the outside temperature.

This formula is based on the assumption that the heat loss through the ceiling into the attic is the same as from the attic through the roof and attic walls into the outside air. The main trouble with it is that if you spent your time working out formulas like this, you would eventually be doing nothing but checking radiation on jobs your competitors had already installed.

(3) Instead of using say $t_i = 70$ and $t_o = -10$F, always call t_o zero and t_i the temperature difference. This simplifies the formula since the second term $t_o(A_r U_r + A_w U_w + A_g U_g)$ in the numerator becomes zero and can be left out. This is hardly an improvement.

(4) Figure out this modified formula for some average conditions and use the results thus obtained.

By following method (4) and making sample calculations for average size and shape attics, it can be

[4]Handbooks give 21.4 and 39.3 as the air leakage figures for 10 and 15 mile per hour winds, respectively. Interpolation will show that for 16 miles per hour the figure is approximately 42.8, or twice as much as for 10 miles per hour. Thus for 16 miles per hour you need simply double the radiation required for air leakage for 10 miles per hour. That is, it becomes 2 × .1284 × length of crack used. For 13 miles per hour, add 50%, and so on.

[5]This omission of ceiling calculations for lower floors of multiflat buildings is not strictly correct, but is probably sufficiently accurate.

shown that the attic temperatures range as follows, depending on the ceiling coefficient:

U_c	t_a	U_c	t_a	U_c	t_a
.05	5	.20	20	.50	35
.10	10	.30	25	.60	40
.15	15	.40	30	.70	43

Consequently, we find for an ordinary insulated ceiling the heat loss in square feet of steam radiation is approximately

$$\frac{wl \times .60 \times 40}{240} = \frac{wl}{10}$$

and for an insulated ceiling ($U_c = .20$)

$$\frac{wl \times .20 \times 60}{240} \text{ or } \frac{wl}{20}$$

On this basis in an ordinary house, since we previously decided that one-half the ceiling loss, or $\frac{wl}{20}$, would be supplied by the downstairs radiators, no heat from upstairs radiators is needed to offset ceiling loss if the ceiling is insulated.

Second Simplification

Of most houses nowadays it can be said that windows are all somewhat the same size and shape. That is, they will run somewhere between 10 sq ft and 15 sq ft each with perhaps 12 sq ft as an average. A 12 sq ft window, say 32 x 54 in, will have 17 ft length of crack. A 10 sq ft window will have about 15½ ft length of crack and a 15 sq ft one 19 ft. That is, the length of crack per sq ft of window is 1.42 for the 12 sq ft window, 1.55 for the 10 sq ft one and 1.27 for the 15 sq ft window.

Taking into consideration that the fit of the windows and consequent air leakage is approximate[6] and that the smaller the window the better the fit is likely to be, thus tending to balance the slightly longer crack length, is it really necessary to make separate calculations for air leakage? Can they not be included in the window area calculations and thus save a lot of work? I intend to show that for all practical purposes they can be.

If we refer back to Fig. 1, we noted that the same number of windows would be used for crack calculations in all the rooms. However, suppose we say that we will consider A and C as average rooms, those where we use one-half the total crack, and that for the others we can later, if we wish, make a correction to take care of the crack of the extra window. Also let us say that each window is 12 sq ft with 17 ft of crack.

Then for each window used for crack, the steam radiation to take care of air leakage is, as we found before,

.1284 × 17 or 2.18 sq ft per window used.

Since, however, we are using only one-half the windows, it is only one half as much, or 1.09 sq ft, for each window in the room. Now the heat transmission radiation through each window in the room is, as we found before,

.377 × 12 or 4.52 sq ft

The total radiation for each window in the room, both transmission and leakage, is therefore

1.09 + 4.52 or 5.61 sq ft

Since we are using a glass area (G) of 12 sq ft, we would get the same result (5.61) by using a coefficient of .468 with G. That is, .468G = 5.61 when G = 12. Consequently, substitute .468G in Formula (1) in place of [.377G + .1284L].

Let us now see how much difference it makes if we use windows of another size, say 10 sq ft and 15 sq ft each. Suppose we say the total window area is 60 sq ft divided into six 10 sq ft windows, five 12 sq ft and four 15 sq ft. For these windows, figured according to the longer term in Formula (1) as compared with the shorter method just outlined, our results will differ only one quarter of a square foot, which is so small that it is not worth considering. Our assumption that air leakage radiation can be lumped in with that for window area is therefore sound.

Now let us see what we should have to do if a room had say two windows on one wall only, or two windows on one side and one on another side. In the first case, according to the rules, we should use the crack of both windows; actually we have used that of only one, and are 2.2 sq ft shy in radiation for a 12 sq ft window. (2.0 sq ft for a 10 sq ft window and 2.4 sq ft for a 15 sq ft one). In the second case we ought to use two windows, but have used 1½. We are, therefore, 1.1 sq ft shy in radiation.

The remedy is fairly obvious. Since the difference between the air leakage radiation for one 12 sq ft window and that for either a 10 sq ft or a 15 sq ft one is not worth considering, in cases where you wish to allow for infiltration for more than half the total crack, just divide the total number of windows by two to find the number you have actually used, subtract it from the number you ought to use and add 2.2 (or 2.0) sq ft of steam radiation for each window (working to half windows) in the difference. It will never be very much.

Third Simplification

Our formula has now become

$$R = .083W_n + .468G + \frac{\frac{1}{2}wl}{10} \quad \ldots\ldots (2)$$

If we use .1 instead of .083 our radiation for walls will be 20% too much. If we use .4 instead of .468 our radiation for windows will be 14½% too little. There must be a relation somewhere between the wall and the window areas where the 14½% too little of one will balance the 20% too much of the other. This occurs, as can be shown by calculation, when the gross wall area (W_g) is five times the glass area (G), or when $W_g = 5G$. This is the same as saying that it occurs when W_n, the net wall area, equals 4G.

We previously decided that if our total radiation turned out to be 5% up or down compared with the

[6]Infiltration tables show that air leakage is about trebled if the width of crack around the window is increased from 1/16 to 3/32 in.

exact figure it could not be considered too bad. If we want to find the conditions where $.1W_n + 4G$ gives 5% too much radiation we can say

$$.1W_n + .4G = 1.05\ (.083W_n + .468G)$$

so that

$$W_n = 7G \text{ or } W_g = 8G$$

Similarly, we can solve for the case when the term gives 5% too little radiation and show that this happens when

$$W_n = 2.1G \text{ or } W_g = 3.16G$$

In other words our term $(.1W_n + .4G)$ is sufficiently accurate between the limits of $W_g = 8G$ and $W_g = 3.2G$ for ordinary rooms.[7]

Fourth Simplification

The formula has now become

$$R = .1W_n + .4G + \frac{\frac{1}{2}wl}{10}$$

However, since $W_n = W_g - G$, the expression $.1W_n + .4G$ is the same thing as $.1W_g + .3G$ or $\frac{W_g + 3G}{10}$

By using the latter it is unnecessary to go to the trouble of subtracting the glass area from the gross wall area to get the net area. The formula thus becomes

$$R = \frac{W_g + 3G + \frac{1}{2}wl}{10} \qquad (3)$$

U Others than .25

We found that .25 was a good average coefficient to use where we are not sure of the construction of the wall or where we do not wish to make any allowance for insulation, if any.

There may, however, be cases where we do wish to make such an allowance. The procedure, though a little more complicated, is still simple if you have the necessary formulas available. If you have to rely on your memory or your reason, you just have to keep your head reasonably clear.

Comparing the expression $\frac{W_n + 4G}{10}$ with the more exact term $.083WN + .468G$ we can see that W_n is too large and $4G$ too small. In ordinary cases we found that they balance each other, so that both expressions give the same result. If, however, we wish to make an allowance for a change in the wall coefficient from .25 to some other figure, it is the $.083W_n$ that ought to be changed and not $\frac{W_n}{10}$ if accuracy is desired.

Now $\frac{W_n}{10}$ can be changed to $.083W_n$ simply by subtracting one sixth of it, and $\frac{G}{10}$ can be changed to $.468F$ by adding one sixth of it. Suppose we have a room with gross wall area 240 sq ft and glass 36 sq ft with three windows. The net wall is therefore 204 sq ft. The correct figure for steam radiation for 80F temperature difference, as we derived it, for walls, windows and air leakage is

$$.083 \times 204 + .468 \times .36 = 33.8 \text{ sq ft}$$

By our formula $\frac{W_n + 4G}{10}$ it is $\frac{204 + 144}{10} = 34.8$ sq ft.[8]

If .083 is the correct wall radiation for $U = .25$, $.1W_n$ is correct for $U = .30$. The glass radiation is still too low.

So if you wish to use some other value of U_w other than .25, remember that by our formula the wall is high and the window is low and that you subtract 1/6 in the former, or else say it is correct for $U_w = .30$, and add 1/6 in the latter.

In the author's next article he will summarize his formula developed in this installment and solve typical examples by both the standard method and his short cut formula.

[7] Use of this term obviously depends on the room having a "normal" number of windows, but would apply excepting in extreme cases such as sun parlors at one extreme and rooms with unusually small or few windows at the other extreme. In these cases a correction can be made as follows:

(1) Mentally divide the gross wall area by 60 to get the "normal" number of windows;

(2) Add 1 sq ft of steam radiation for each window above the normal number, or you can subtract 1 sq ft for each window below the normal number.

[8] We found that if greater accuracy is desired we can divide W_g by 60 to get the normal number of windows and add or subtract 1 sq ft for each window above or below the normal. In this case $240 \div 60 = 4$. As we have only three windows we can subtract 1 sq ft making our result 33.8, the same as the exact figure.

The Atmosphere of Mars

The thin atmosphere of Mars above each square foot of the planet's surface contains less than one-twentieth as much water vapor as does that of the earth.

The terrestrial atmosphere contains about two-tenths of 1% of water vapor.

This is the conclusion of Dr. Walter S. Adams, director of the Mount Wilson Observatory of the Carnegie Institution of Washington, from the most exact spectroscopic observations yet made on Mars.

The measurements also confirm the earlier conclusion that Mars has extremely little if any free oxygen, in spite of the vast amounts which may have combined with its rocks. It is practically certain that no free hydrogen, the lightest of gases, and the other constituent of water vapor, can be present in the atmosphere of Mars.

Confirmation of the extreme dryness of the Martian atmosphere—far too dry, it is likely, to permit the existence of most forms of life known on earth—leaves as much of a mystery as ever the nature of the supposed *polar ice caps* on the planet. These can be seen to advance in the Martian winters and recede in the Martian summers. Even if they are frozen water, however, the entire water content cannot be large and their influence upon the general atmosphere of the planet must be slight.

Air Conditioning for Growing Grass Controlled by Program Clocks

THE voluminous publications of the State and Federal institutions bear witness to the attention given to various phases of growing commercial plants, fowls, and livestock. Until recently, however, no one gave too much thought to pasture grasses.

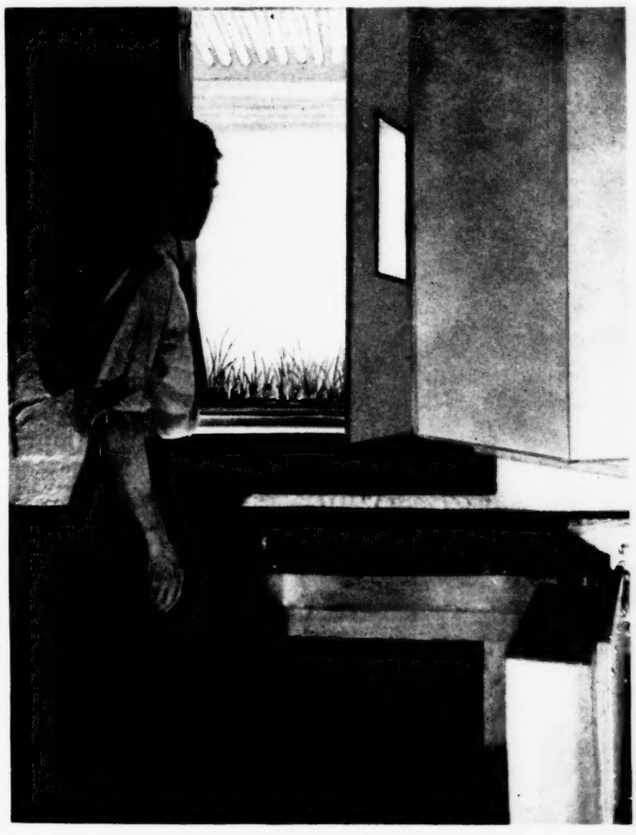
This is no longer true. The reasons for good or bad pastures are now being studied, and the same progress that has characterized other efforts toward farm improvement promises to be made. The Department of Agriculture has set up a Regional Pasture Research Laboratory at State College, Pa., which is investigating Northeastern pasture problems.

Among the problems involved has been that of devising equipment and making daily readings to show the amount of heat obtained from the sun on a square foot of ground, as the seasons vary through the years. Thousands of plants, some of them grown outdoors and some in greenhouses, have been experimented with, in the effort to develop better pastures.

A unique achievement on the part of the Laboratory is the new 4-compartment test box in which pasture plants can be grown under weather conditions equivalent to those in any part of the civilized world. These compartments have separate temperature control for the soil boxes in which the plants are actually grown, and for the air in the boxes surrounding the plants.

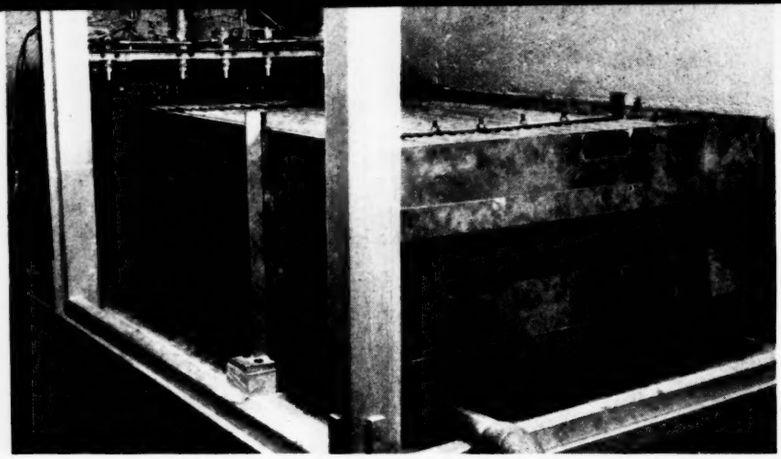
Each box measures 5 ft square by 7 ft high, and is insulated with 6 inches of corkboard. The interior space is sealed against moisture flow through the walls by a lining of sheet copper painted white so as best to reflect the *sunlight*. Three heavily insulated doors permit access to each compartment; the two bottom doors open into the lower part under the soil box, which stands on legs. Inside the upper door is a thin metal one provided with a window. This inner door keeps the conditioned air in the box from rushing out when the main door is opened, and also permits inspection of plants without disturbing conditions in any way.

The top of each box is made of three layers of plate glass and above these is a battery of 18 fluorescent lights, the tubes of which are each 4 ft long. These lights are mounted on a carriage which can be pulled forward to make them accessible. Arrangements have been made to run water across the top of each compartment if desired, and dyes can be added to this water to change the color and study the effectiveness of the various wave lengths of light. Separate program clocks govern the lights, making them come on at *dawn* and go off at *sunset* to simulate various day lengths encountered at different latitudes.

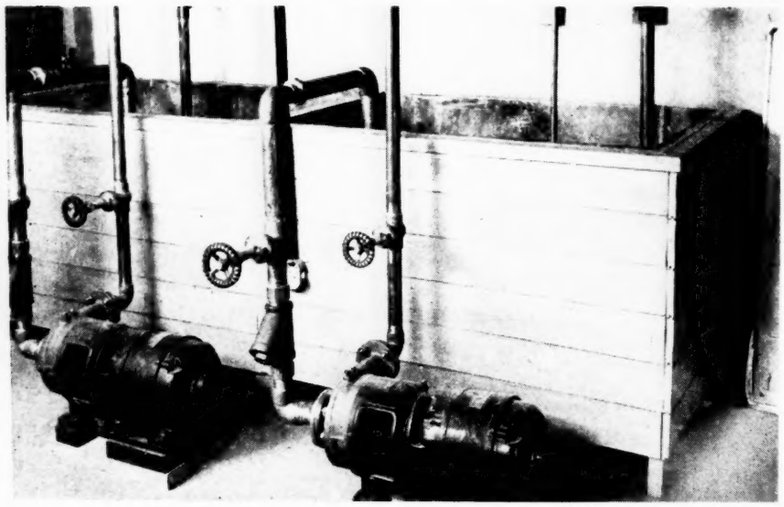


Looking into one of four test boxes, showing plants growing under various conditions. Window in inside door allows plants to be inspected without disturbing air conditions.

Behind the test boxes at the Regional Pasture Laboratory, showing the recording instruments, control equipment, ducts, pumps and connections, before insulation was applied.



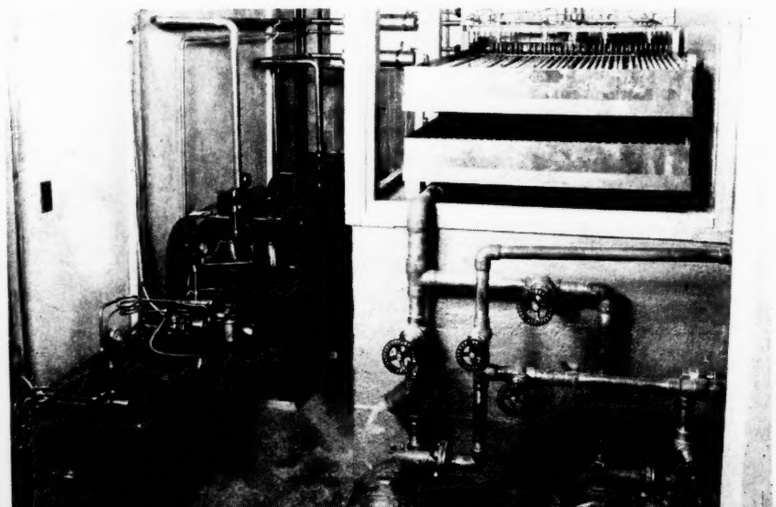
Each of the four refrigerating units is connected to a separate group of the cooler pipes shown above.



The warm and hot brine tanks and pumps, shown above.

(Below) Three of the four test boxes one of which has the lights rolled forward.

(Below) The four refrigerating units and instant cooler which handles the Prestone used as brine.



All other conditions inside the boxes are under similarly accurate environmental control. The dry-bulb temperature inside each compartment can be controlled within ±1F and the relative humidity within 5%. This humidity can be varied between 20% and saturation. The soil boxes are really insulated baths of brine, the temperature of which is accurately controlled, and into which the jars containing the plants are lowered.

Brine is used for both heating and cooling, throughout the system; actually the brine is Prestone. Agitation of the brine inside the soil tanks is obtained by constant recirculation. Four small double-pipe heat exchangers with warm brine in one part and cold brine in the other, are used for regulating brine temperature. Each compartment also has its own brine pump. This equipment for regulating soil-box temperature constitutes the simplest of four distinct brine systems.

The air conditioning system has ducts of pure copper and all the controls in contact with the air are of copper or brass. Bristol valve positioners control the feed of steam for humidity, or the flow of hot, medium, or cold brine as needed. The cold brine temperature sometimes gets as low as —10F. The cold brine is stored in a tank containing four or five hundred gallons, above which is mounted an instant cooler. This cooler has copper pipes and troughs and is 34 pipes wide. Each of the four refrigerating units is connected to a separate group of these cooler pipes. The hot brine can be heated to 150F by steam. The warm brine, which never gets above 70F, is in a smaller tank at the end of the hot brine tank. All the brine mains are contained in an insulated trunk shown at the bottom of the photograph of the rear side of the boxes. Finned coils are placed in the air stream, and are fed with brine at exactly the temperature needed.

Two Frick low pressure units, each of 5 hp size, are connected to the instant cooler. Either machine is capable of carrying the normal load while the other stands in reserve, but both are used for bringing the brine down to temperature before a test run is made. Two smaller machines of another make, which happened to be on hand, are tied-in to the refrigerating system, and are useful for running under very light loads. The machines go into operation in steps as the load increases.

To start a test, shoots from the same plant are placed in each of the four compartments. Charts are then drawn for a week in advance, showing the conditions of light, temperature and humidity desired at various hours of the day and night. These charts are then cut out with shears on forms of sheet aluminum, which are placed in the Bristol control instruments provided for the purpose. There is one chart for the condition of the air and another for the condition of the soil. Recording thermometers register the results obtained through the use of these control charts or forms, which are really cams. Light arms, equipped with rollers, follow the outside edges of the cams as these slowly revolve on time clocks. All the controls are air operated. Filters or dryers clean the air, which must all pass through a room at 34 to 36F to eliminate excess moisture.

The circulation of conditioned air through the boxes has been arranged so that the air velocity over the plants is generally only about 85 ft per min.

Air Conditioning for Sweet Potato Storage Houses

Industrial uses of sweet potatoes have greatly increased during the last few years due, to a great extent, to the work of the U. S. Department of Agriculture and various state universities. The growing importance of this crop has turned attention to the proper air conditions for storing sweet potatoes. In this article, which is based on a paper by G. H. Dunkelberg of the South Carolina Agricultural Experiment Station in "Agricultural Engineering", the need for maintaining one set of air conditions during the curing period and another set during the storage period is pointed out.

SINCE sweet potatoes are living organisms it is necessary to maintain proper air conditions in the storage house during the curing and storage periods.

During harvesting, the sweet potatoes are always wounded. If not cut by the harvesting machine or bruised in handling, the potato always has one wound where it has been severed from the stem. If the potatoes are to have a long storage life their wound must be healed quickly and the skin developed rapidly. If this is not accomplished quickly, water necessary for the life process escapes and the potato shrinks badly.

Air Conditions for Healing

Under favorable conditions of temperature and humidity a permanent layer of cells is developed below the outer layer of the potatoes which forms a permanent elastic set of tissue. This layer prevents the loss of moisture through the skin and wound and also prevents the entry of diseased organisms through the wound. It has been found that this layer will develop quickly when the potato is exposed to air temperatures of 80 to 90F and relative humidities of 80 to 95%. A lower temperature or humidity will retard or even inhibit this action. Temperatures above 90F may cause the potatoes to decay and relative humidities high enough to cause condensation on the surface of the potatoes would likewise produce conditions favorable for the development of storage rots.

While the wounds are being healed and the skin is being thickened changes are taking place within the potato. Most important is the speeding up of the rate of respiration which results in the sugar breaking down into carbon dioxide and water with the liberation of energy which is essential in keeping alive the organism. The carbon dioxide and water escape through the skin into the air. The water loss is replaced by the water of respiration so that the percentage of water in the potato remains practically the same before curing, after curing and during the storage period.

Air Conditions for Storage

After the potatoes are cured they must be stored until they are sold or used. The proper temperature for storage is between 50 and 55F at relative humidities high enough to retard evaporation through the skin though not so high as to cause condensation.

Observations at Clemson Agricultural College indicate that a relative humidity of 80 to 85% is satisfactory and does not permit condensation. The storage temperature must be high enough to keep the organisms alive and low enough to keep the shrinkage and loss of wet to a minimum.

At the present time there is little information available on the amount of air change necessary except in so far as it affects the maintenance of temperature and humidity. At the present time controlled experiments are being contemplated at Clemson to determine the ventilation requirements of storage houses.

The storage houses in order to do a good job of curing and storing must be sanitary and capable of being cleaned to eliminate rot organisms. The building must be tight and well insulated with positive ventilation controls for the maintenance of the proper air conditions. To secure a uniform temperature throughout the building it is necessary to have a well distributed heat supply and a means of preventing wide fluctuations of temperature.

Walls and ceilings of the better constructed houses are usually of several thicknesses of wood sheathing and are made tight by building paper. It may be that some kind of commercial insulating materials may prove more economical than the present practice. Regardless of the insulating material used, with the high humidity necessary in a sweet potato house, a vapor barrier on the inside would improve the insulating value. The elimination of windows in the house would lower both heat loss and cost of construction.

Ducts for supplying air to the building should come from below as side ventilators cause cold spots in the potatoes next to the opening. All doors and ventilators should be weatherstripped.

A thermostat will aid greatly in maintaining a uniform temperature and relative humidity. From 0.37 to 0.55 kwhr of electricity were necessary to cure each bushel of potatoes in the curing house at Clemson in 1939, and a little more than one kilowatt-hour was necessary to cure each bushel in 1938. The greater quantity of electricity used in 1938 was undoubtedly due to the difference in temperature of the periods during which the roots were harvested. Harvesting began two weeks earlier and was performed during warmer weather in 1939 than in 1938. For the storing period from 1.74 to 2.72 kwhr of electricity were used in 1939-40 while 1.28 to 1.99 kwhr were used in 1938-39. This difference is principally due to the difference in temperature between the two seasons.

For the entire period, an average of 2.69 kwhr per bushel were necessary in 1939-40 and 2.73 kwhr per bushel were necessary in 1938-39. This house is small, the two rooms in the test containing 360 bushels. Larger houses should require less electricity per bushel.

Summary of the Census of Construction

AS part of the 1940 Census the Department of Commerce included, as it did in 1930, a Census of Construction. Data from this are of great significance to the building industry.

The accompanying tables from the 1940 Census of Construction are those of special interest to heating and air conditioning men for they summarize the important information about those contractors who are most concerned with heating, ventilating and air conditioning work, broken down by region (see map), by size of business (over or under $25,000 of total contracts performed), and by type of contractor. Of possible value in establishing sales quotas, for instance, the last column on value of equipment installed, or bought, shows the importance in each group of the relatively few who do over $25,000 of work but buy the major portion of equipment.

Prepared under the direction of Fred A. Gosnell,

CENSUS OF CONTRACTORS ENGAGED WHOLLY OR PARTLY IN HEATING, VENTILATING, PIPING AND AIR CONDITIONING

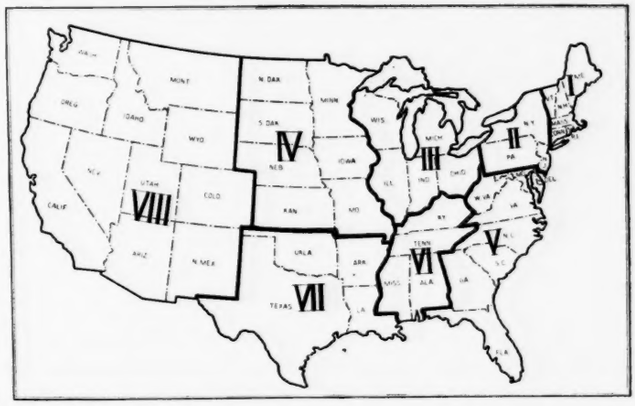
(ABSTRACTED FROM THE CENSUS OF CONSTRUCTION, 1940 CENSUS, COVERING THE YEAR 1939. THE $25,000 IN THE HEADINGS REFERS TO THE ANNUAL VOLUME OF BUSINESS OF THE CONTRACTOR)

REGION	NUMBER OF ESTABLISHMENTS			VALUE OF WORK PERFORMED (ADD 000)			NUMBER OF EMPLOYEES‡			PAY ROLL (ADD 000)‡			EQUIPMENT AND MATERIALS USED AND INSTALLED (ADD 000)		
	TOTAL	OVER $25,000	UNDER $25,000	TOTAL	OVER $25,000	UNDER $25,000	TOTAL	OVER $25,000	UNDER $25,000	TOTAL	OVER $25,000	UNDER $25,000	TOTAL	OVER $25,000	UNDER $25,000
AIR CONDITIONING CONTRACTORS†															
New England	46	21	25	1,771	1,500	271	349	282	67	599	511	88	827	696	131
Middle Atlantic	149	76	73	11,430	10,576	854	1,691	1,485	206	3,012	2,778	234	6,614	6,185	429
East North Central	231	76	155	8,446	6,870	1,576	1,397	1,068	329	2,367	1,992	375	4,634	3,811	823
West North Central	92	34	58	3,847	3,167	680	567	433	134	879	731	148	2,303	1,923	380
South Atlantic	76	44	32	4,526	4,173	353	886	804	82	1,197	1,114	83	2,528	2,346	182
East South Central	26	12	14	1,186	1,046	140	285	251	34	326	294	32	605	539	66
West South Central	69	34	35	5,223	4,834	389	853	760	93	1,248	1,158	90	3,263	3,037	226
Mountain	30	9	21	691	502	189	141	101	40	182	145	37	378	278	100
Pacific	79	32	47	3,276	2,791	485	585	507	78	905	811	94	1,759	1,503	256
U. S. TOTAL	798	338	460	40,396	35,459	4,937	6,754	5,691	1,063	10,715	9,534	1,181	22,911	20,318	2,593
HEATING AND PIPING CONTRACTORS															
New England	285	65	220	6,711	4,851	1,860	1,196	799	397	1,878	1,412	466	3,802	2,867	935
Middle Atlantic	866	216	650	26,106	20,845	5,261	4,550	3,373	1,177	7,851	6,640	1,211	13,480	10,928	2,552
East North Central	912	237	675	22,100	16,127	5,973	4,425	2,936	1,489	6,726	5,158	1,568	11,559	8,506	3,053
West North Central	282	72	210	7,002	5,164	1,838	1,391	909	482	1,981	1,533	448	3,698	2,720	978
South Atlantic	196	70	126	6,000	4,907	1,093	1,180	930	250	1,428	1,204	224	3,530	2,928	602
East South Central	81	23	58	1,626	1,157	469	355	236	119	392	289	103	950	683	267
West South Central	28	9	19	587	419	168	122	82	40	142	102	40	345	264	81
Mountain	67	17	50	1,191	627	564	284	139	145	328	184	144	695	377	318
Pacific	165	34	131	4,227	2,951	1,276	748	478	270	1,070	786	284	2,074	1,433	641
U. S. TOTAL	2,882	743	2,139	75,550	57,048	18,502	14,251	9,882	4,369	21,796	17,308	4,488	40,133	30,706	9,427
HEATING AND PIPING CONTRACTORS, WITH SHEET METAL															
New England	24	3	21	454	262	192	107	63	44	140	86	54	220	153	67
Middle Atlantic	249	50	199	7,792	6,279	1,513	1,397	1,058	339	2,641	2,304	337	3,541	2,856	685
East North Central	680	103	577	12,664	7,748	4,916	2,414	1,372	1,042	3,460	2,348	1,112	6,374	4,008	2,366
West North Central	288	39	249	3,964	1,972	1,992	847	390	457	935	494	441	2,039	1,070	969
South Atlantic	49	14	35	4,847	4,495	352	692	582	110	1,311	1,215	96	3,104	2,941	163
East South Central	52	11	41	876	499	377	229	121	108	240	149	91	424	245	179
West South Central	15	6	9	361	285	76	124	96	28	144	122	22	143	103	40
Mountain	63	15	48	1,248	771	477	242	148	94	299	201	98	651	412	239
Pacific	152	48	104	4,091	2,994	1,097	769	545	224	1,089	825	264	2,064	1,557	507
U. S. TOTAL	1,572	289	1,283	36,297	25,305	10,992	6,821	4,375	2,446	10,259	7,744	2,515	18,560	13,345	5,215
HEATING, PIPING AND PLUMBING CONTRACTORS															
New England	1,562	171	1,391	20,799	9,302	11,497	3,769	1,676	2,093	4,910	2,590	2,320	10,710	5,041	5,669
Middle Atlantic	5,095	620	4,475	84,027	50,119	33,908	15,255	8,808	6,447	21,984	15,062	6,922	43,600	27,400	16,200
East North Central	2,530	460	2,070	52,460	34,939	17,521	9,564	5,954	3,610	14,347	10,502	3,845	27,331	18,643	8,688
West North Central	1,391	211	1,180	23,118	13,963	9,155	4,420	2,416	2,004	5,486	3,650	1,836	12,911	8,266	4,645
South Atlantic	1,197	333	864	32,451	24,278	8,173	6,975	4,903	2,072	7,848	6,074	1,774	8,537	14,287	4,250
East South Central	391	84	307	8,636	5,997	2,639	2,020	1,301	719	2,060	1,503	557	4,827	3,463	1,364
West South Central	222	75	147	7,491	6,251	1,241	1,573	1,234	339	1,807	1,534	273	4,395	3,781	614
Mountain	349	75	274	7,577	4,999	2,578	1,324	850	474	1,708	1,278	430	4,350	2,942	1,408
Pacific	429	136	293	14,516	11,788	2,728	2,481	1,976	505	3,858	3,321	537	7,956	6,507	1,449
U. S. TOTAL	13,166	2,165	11,001	251,075	161,635	89,440	47,381	29,118	18,263	64,008	45,514	18,494	134,617	90,330	44,287

‡Employees and payroll include paid executives of corporations, but not the number and compensation of proprietors of unincorporated business. †Air conditioning with or without heating, piping, plumbing, and sheet metal.

chief statistician of business, Bureau of the Census, the Summary of Construction Census data is available in pamphlet form from the Bureau. Individual state data are available broken down by cities in separate publications.

In all cases, the location of the contractor's headquarters and not that of the project determines the geographical classification. All figures cover work done in 1939, whether started or finished or not, during that year, by the contractor's own forces.



(Right) Map showing regional classification used in the tables.

CENSUS OF CONTRACTORS ENGAGED WHOLLY OR PARTLY IN HEATING, VENTILATING, PIPING AND AIR CONDITIONING

(Abstracted from the Census of Construction, 1940 Census, Covering the Year 1939. The $25,000 in the Headings Refers to the Annual Volume of Business of the Contractor)

Region	Number of Establishments			Value of Work Performed (Add 000)			Number of Employees‡			Pay Roll (Add 000)‡			Equipment and Materials Used and Installed (Add 000)		
	Total	Over $25,000	Under $25,000	Total	Over $25,000	Under $25,000	Total	Over $25,000	Under $25,000	Total	Over $25,000	Under $25,000	Total	Over $25,000	Under $25,000
Heating, Piping and Plumbing Contractors, with Sheet Metal															
New England	433	94	339	8,506	5,403	3,103	1,762	1,077	635	2,534	1,775	759	4,218	2,733	1,485
Middle Atlantic	619	117	502	13,777	9,387	4,390	2,680	1,816	864	3,846	2,901	945	7,312	5,125	2,187
East North Central	385	95	290	13,593	10,952	2,641	2,446	1,906	540	3,828	3,327	501	7,335	5,897	1,438
West North Central	237	39	198	4,166	2,611	1,555	824	500	324	905	646	259	2,505	1,623	882
South Atlantic	138	65	73	6,859	6,084	775	1,560	1,371	189	2,055	1,886	169	3,734	3,336	398
East South Central	52	18	34	1,791	1,439	352	427	325	102	494	421	73	937	756	181
West South Central	39	23	16	4,651	4,544	107	649	617	32	989	971	18	2,636	2,586	50
Mountain	70	23	47	2,469	2,019	450	479	394	85	633	543	90	1,409	1,173	236
Pacific	149	59	90	6,572	5,639	933	1,127	944	183	1,760	1,554	206	3,675	3,210	465
U. S. TOTAL	2,122	533	1,589	62,384	48,078	14,306	11,954	8,950	3,004	17,044	14,024	3,020	33,761	26,439	7,322
Sheet Metal Contractors															
New England	213	21	192	2,888	1,578	1,310	651	343	308	933	575	358	1,093	623	470
Middle Atlantic	725	59	666	8,355	4,132	4,223	1,653	760	893	2,484	1,453	1,031	3,418	1,804	1,614
East North Central	1,272	83	1,189	12,662	5,545	7,117	2,626	1,180	1,146	3,810	2,138	1,672	5,353	2,456	2,897
West North Central	523	30	493	4,170	1,461	2,709	911	321	590	1,128	511	617	1,751	613	1,138
South Atlantic	213	15	198	1,978	620	1,358	590	191	399	580	210	370	817	276	541
East South Central	114	3	111	1,007	281	726	289	56	233	276	93	183	420	138	282
West South Central	254	16	238	2,167	693	1,474	628	190	438	634	251	383	813	260	553
Mountain	120	10	110	1,235	407	828	277	89	188	298	113	185	555	182	373
Pacific	438	55	383	5,752	2,854	2,898	1,149	546	603	1,607	870	737	2,469	1,350	1,119
U. S. TOTAL	3,872	292	3,580	40,214	17,571	22,643	8,774	3,676	5,098	11,750	6,214	5,536	16,689	7,702	8,987
Weatherstripping Contractors															
New England	24	5	19	673	594	79	170	161	9	306	296	10	202	179	23
Middle Atlantic	107	13	94	1,819	1,192	627	439	306	133	704	548	156	675	423	252
East North Central	91	13	78	1,659	1,060	599	387	274	113	641	483	158	597	366	231
West North Central	56	5	51	841	605	236	234	182	52	339	275	64	297	210	87
South Atlantic	43	8	35	965	714	251	245	181	64	368	299	69	388	289	99
East South Central	19	4	15	284	167	117	67	34	33	88	58	30	132	87	45
West South Central	24	2	22	328	*	*	79	*	*	127	*	*	108	*	*
Mountain	13	2	11	105	*	*	27	*	*	35	*	*	36	*	*
Pacific	42	4	38	540	302	238	145	88	57	225	161	64	153	79	74
U. S. TOTAL	419	56	363	7,214	4,856	2,353	1,793	1,283	510	2,833	2,225	608	2,588	1,706	882
Insulation Contractors															
New England	50	22	28	1,977	1,683	294	478	391	87	769	664	105	852	741	111
Middle Atlantic	171	70	101	8,279	7,230	1,049	2,145	1,857	288	3,380	3,051	329	3,373	2,939	434
East North Central	216	82	134	7,348	5,918	1,430	1,904	1,501	403	2,738	2,312	426	3,062	2,458	604
West North Central	92	32	60	3,213	2,659	554	860	685	175	1,095	944	151	1,464	1,237	227
South Atlantic	54	27	27	2,042	1,693	349	592	470	122	806	696	110	880	747	133
East South Central	12	3	9	230	182	48	68	44	24	68	58	10	135	105	30
West South Central	35	12	23	1,005	824	181	314	240	74	363	303	60	495	407	88
Mountain	20	3	17	391	232	159	98	56	42	114	70	44	178	98	80
Pacific	58	22	36	2,024	1,711	313	511	429	82	692	609	83	917	763	154
U. S. TOTAL	708	273	435	26,509	22,132	4,377	6,970	5,673	1,297	10,025	8,707	1,318	11,356	9,495	1,861

‡Employees and payroll include paid executives of corporations, but not the number and compensation of proprietors of unincorporated business.
†Air conditioning with or without heating, piping, plumbing, and sheet metal. *Withheld to avoid disclosure.

Details of Duct Connections for Vehicular Tunnel Ventilation

By F. F. KRAVATH†

In the article in last month's issue the author classified the various methods of ventilating vehicular tunnels. In this installment he discusses orifices, pressure and exhaust ducts, risers, air filtration and the arrangement of fan houses. In the concluding article of this three-part series, to appear next month, fan drives and controls will be taken up.

ARRANGEMENT of orifices cannot be stressed too much. It is essential that all dead spots be eliminated which might harbor a concentration of fumes greater than normal. Accordingly, orifices should be placed over the walkways to sweep away any fumes which might tend to be pocketed there. Enough orifices should always be used, both in the exhaust and pressure ducts, so that the velocity of airflow through the orifices will be relatively low. The velocity through the orifices should not exceed 3000 fpm and if possible, should be lower.

Assuming the orifice to be of such a shape that the resistance loss for this piece will approximate one-half a velocity head, with an orifice velocity of 3000 fpm this loss would approximate 0.281 in. water gauge. If the velocity were 4000 fpm, the loss would approximate 0.500 in. water gauge. Considering the fact that volumes will be handled in some cases as high as 1,500,000 cfm, the difference in horse-power required for this particular increase in orifice velocity from 3000 to 4000 fpm is just about 70 hp, assuming a fan mechanical efficiency of 60%. This is admittedly a minor item, but if by the efficient design of a few minor items thousands of dollars of fans, motors, drives and electrical equipment, as well as continual operating charges may be saved, they then become important enough to merit the attention of the designer.

Pressure and Exhaust Ducts

These ducts, due to the construction of the tunnel cross-section will generally be sectors of circles or their equivalent. They will also, generally, be large enough in cross-sectional area to be able to handle the full volume of blowing or exhausting air at reasonable velocities, but where the velocity within either of these ducts becomes excessive—4000 fpm should be a maximum unless it is absolutely necessary to go above this figure—air should be introduced to the ducts, or exhausted, as the case may be, at enough places to reduce the figure to the 4000 fpm stated. In any event, a balance must be struck between the cost of furnishing additional fan houses, delivery and exhaust risers, or providing larger pressure and exhaust ducts, or operating the ventilating system at the higher velocities.

In most long, well-traveled tunnels, at least two fan houses and delivery and exhaust risers for each are necessary. Sometimes, though rarely, as many as four may be necessary. The point to be remembered is that these ducts should be made as large as is possible—provided the volume of air calls for it—so that the velocity of flow may be kept at a minimum. The need for velocities below 4000 fpm becomes readily apparent when the resistance to flow in a duct of this sort is computed. Due to the high ratio of perimeter to cross-sectional area of a sector of the sort described, the resistance to flow in such a shaped duct will be excessive as compared to the resistance within a duct of circular or square cross-sectional construction. Again, the lining of the ducts will generally be concrete, as poured, and as such will be considerably rougher than the ordinary sheet steel duct. The combination of the two factors results in an unfavorable condition which must be reckoned with.

Where it is absolutely necessary to go above 4000 fpm, the ducts should be lined with a light gauge of galvanized iron sheet so as to present the smoothest surface to flow that is posssible. This need only be done at those portions of the ducts in which the velocity exceeds 4000 fpm, such as at the delivery and vertical exhaust risers, points of juncture with the tunnel ducts, and a reasonable distance from those points as determined by the velocities within the tunnel ducts.

Delivery and Exhaust Risers

The delivery and exhaust risers are the ducts connecting the blowers and exhausters in the fan house or houses with the pressure and exhaust ducts in the tunnel. These will almost always be constructed of concrete underground and of a sheet steel above ground. Since the most difficult connections to be made are between the fans and the ducts and these will be located above ground at the fan houses, they then can be made of sheet steel and, accordingly, can be made as efficiently as possible. The connections between risers and tunnel ducts are not nearly so complicated and can be made quite efficiently of concrete. The riser proper, as previously stated, must of necessity be made of concrete if connection to the tunnel is to be made at any great depth. The cost of fabricating and erecting a steel duct of this size with sufficient strength to maintain its desired shape would in most cases be considerably more expensive than the furnishing of a concrete shaft.

There are three important design points affecting the

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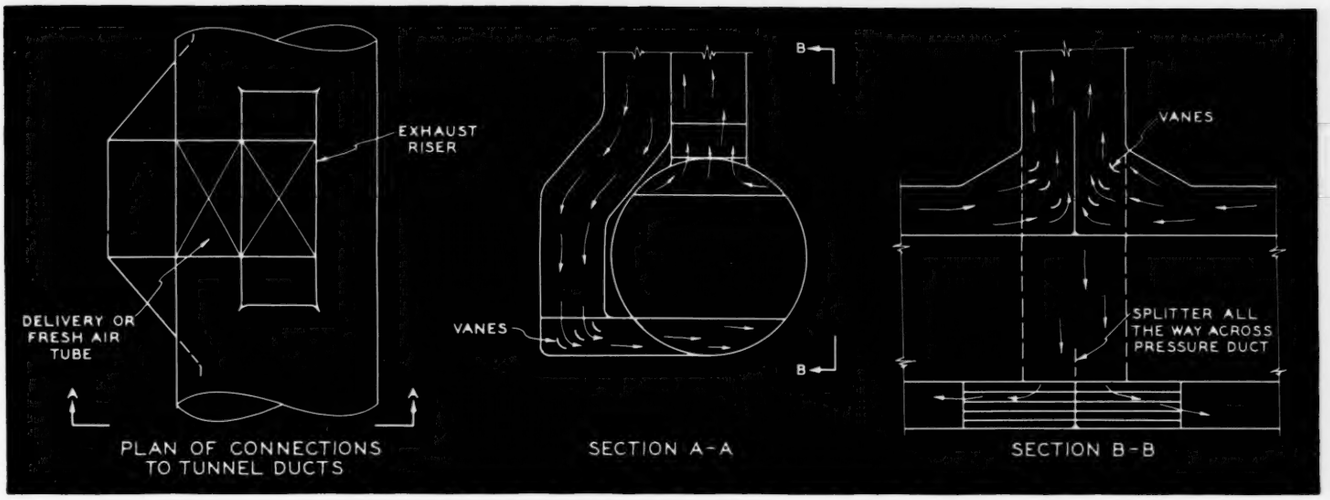

Fig. 8. Showing connections between risers and tunnel ducts.

resistance of the delivery and exhaust risers to the flow of air. Since it is axiomatic that the resistance must be kept at an absolute minimum consistent with reasonable initial charges, the three points in question should be investigated thoroughly to determine the best design for the particular job. The connections between fans and risers, between risers and tunnel ducts, and the size and surface conditions of the risers themselves are the points to be discussed. As can readily be seen, there will of necessity have to be more than one fan for each of the risers. In many cases, there are as many as ten or more fans connected to each duct. The manner in which the air streams from the various fans converge and enter the pressure duct, or split up in leaving the exhaust duct to enter the exhaust fans determines the resistance to flow to be overcome in passing this fitting.

Similarly, the manner in which the air leaves the delivery duct and enters the pressure duct, or leaves the exhaust duct and enters the exhaust riser determines the resistance at this point. It would be a simple matter if by merely making these connections so abnormally large that the air velocity would become negligible —that the resistance would become likewise negligible.

However, cost precludes such a step. The velocity should be kept within reasonable limits—say about 3000 fpm, but from that point on resistance of the fittings should be kept low by efficient air design. Illustrated in Fig. 8, are methods of making efficient connection between the risers and the tunnel ducts. Since a hole will have to be bored or dug from the fan house down to the tunnel, in order to make this hole as small as possible and reduce the cost, the delivery and exhaust risers should be placed together, as illustrated, and the shape of the shaft should approach a square as much as possible. Due, however, to the fact that the resistance to flow in each of the ducts will be at a minimum for any set cross-sectional area if the ducts are made square in section, this becomes an important factor and a balance must be struck between the two.

Referring again to the illustrations, it can be seen that in order to save space rectangular elbows or tees are utilized. They are supplied with splitter vanes and an elbow so constructed has no more resistance to flow than a wide throat radius elbow. Where the risers form a tee (as illustrated) rather than an ell with the tunnel ducts, the middle of the fittings should be divided and the splitter should be carried all the way across the tunnel ducts, effectively splitting them. This will aid effectively in the reduction of turbulence with its consequent resistance loss. The method shown is only one way of making an efficient connection. Depending on the particular tunnel to be ventilated, the volume of air to be handled, whether or not a tee connection is necessary, and the nature of the medium being tunneled through (whether rock or soil), other methods will present themselves and may prove more satisfactory.

Fig. 9 illustrates connections between the fresh air

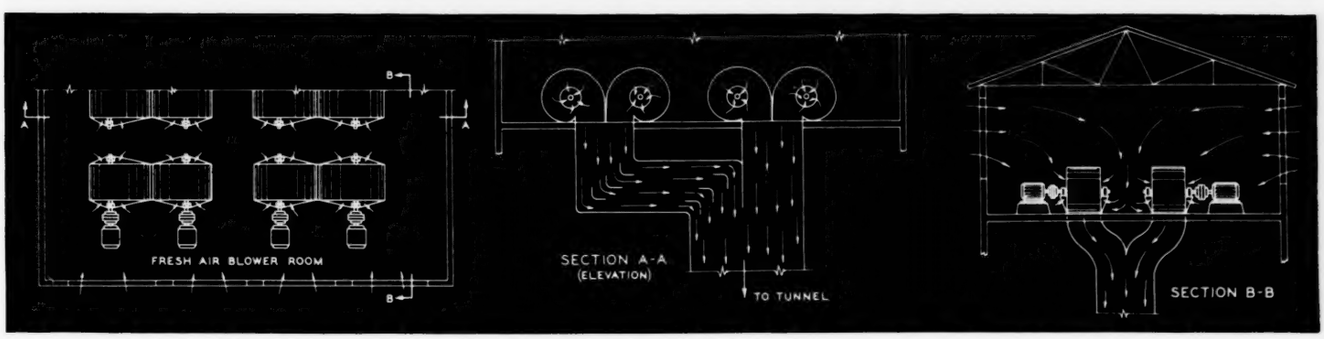

Fig. 9. Eight double inlet, down blast discharge blowers arranged for efficient connection to fresh air riser and for economically sized fan house.

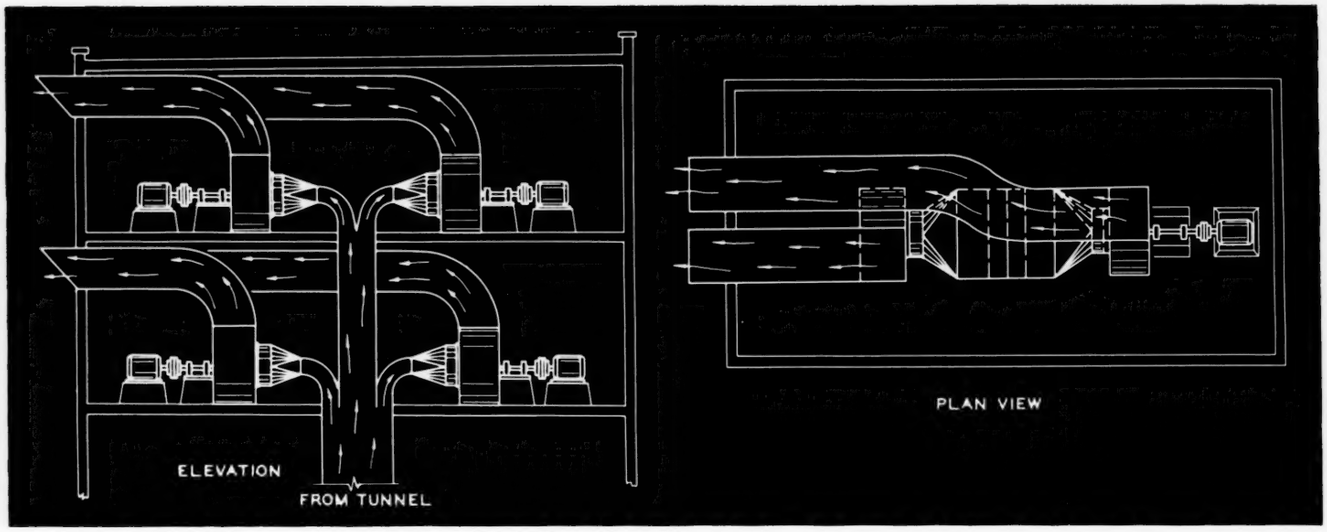

Fig. 10. Illustrating exhaust fan connections to exhaust riser where plot area is at a premium.

blowers and the fresh air delivery tube to the tunnel. Here, again, it is attempted to bring the streams of air from the various blowers together into one duct with a minimum of turbulence and resistance loss and as cheaply as possible. The arrangement of fans shown is only one of many satisfactory ways of doing the same thing. The fans could have been put into one row and then using either up-blast, top-horizontal, or angular-up discharges could have been connected together very nicely into one horizontal duct running over the fans. Again, in a single row but with down-blast discharge the fans can be nicely connected into either a vertical or a horizontal duct running under the floor. If plot area is at a premium as would be the case in a large city, especially at the waterfront, it would prove more advantageous to place component units of the same system on different floors and join them with a vertical duct. This type of connection is illustrated in Fig. 10 which shows the connections between exhaust fans and exhaust riser.

Regarding the method of discharging from the exhaust fans to the atmosphere, this can be done either as shown, individually for each fan, or the various ducts can be joined together into one. Whichever is the cheaper thing to do should be done. There is no absolute necessity for a single discharge nor is it at all necessary to carry the point of discharge to some remote point. The gases being discharged are not poisonous, they are merely *air* at the safe limit of pollution. This air is being replaced with fresh air so as to offset the effect of increased pollution by motor vehicles. We thus keep the concentration of air pollutants down. However, it would be well to discharge this *stale* air in the same direction that the prevailing wind blows so as to prevent as much as possible the chance of any of this same air being picked up by the fresh air fans and carried back to the tunnel.

Air Filtration

In regard to the air delivered to the tunnels as fresh air, it is unnecessary to go to any great lengths to purify or filter this at the inlet or any other point before delivery. Filtration of such a huge volume of air will require an expensive filtering plant, an appreciable maintenance burden, and the additional resistance imposed to flow will add fans, motors, drives, and additional current charges that might well have been avoided. It is far wiser to draw the intake air from a point at which the air is relatively uncontaminated, even if this means a longer inlet duct than would otherwise be necessary. The frictional resistance encountered in well-designed ducts is negligible for any length that would probably be needed. Only if there is no alternative to introducing unwholesome air to the tunnel should a filtering plant be utilized. If it is necessary to go to the expense of a filtering plant, it is recommended that washable type filters rather than the throwaway type be used. If a satisfactory filter of the rapping type can be obtained economically (either in the cloth dust filter type or in the electrostatic precipitator) this should be preferred since it will save manual handling of the filter parts. While filtering plants of this type are bound to be expensive for tunnel ventilation, the expense will be more initially and less from that time on. The cost of replacing throwaway type filters for such an installation would be prohibitive.

Fan House Arrangements

There are various methods of arranging the blower and exhaust fans within a single house. This can be done all in one room or the blowers, handling the fresh air, can be placed in one room and the exhausters, handling the stale air, in another. Again, it may be more convenient to have the various blowers directly under one another and the exhausters arranged in the same way. Generally, the considerations governing will make one arrangement preferable. The fan house may of necessity have to be of a small plan area, or it may be quite large. The number of fans necessary may be many or again it may be few, they may be large or preferably be smaller, they may be arranged for group drive or for individual drive, and they may be driven in any one of a number of different ways. All of these considerations will affect the size and construction of the fan house so that the actual choice open to the designer may be limited.

ABSTRACTS of Current Papers, Books and Pamphlets

Oil Burner Performance

Eighteen months of experimental work on pressure-type oil burners has revealed some interesting new facts on oil burning and corroborated certain opinions previously unsubstantiated. The research was conducted at the Iowa Engineering Experiment Station, where tests were made to determine the causes of waste in fuel consumption of domestic oil burners.

The results indicate that probably the greatest cause of waste may be attributed to the common householder's conception that increasing the amount of air introduced into the burner increases the economy of operation. The opposite was found to be true. Reducing excess air was found to cause a higher combustion-chamber temperature and a lower stack temperature which results in a higher efficiency.

Four high-pressure gun-type burners were tested in two standard cast-iron boilers to ascertain the effect of performance of various burner makes, boiler types, firebrick compositions, and cycling rates.

The oil-designed boiler was found to be superior in economy of operation to the general-purpose conversion boiler tested. The least efficient burner operated more economically in the oil-designed boiler than the most efficient burner in the conversion job. However, it was found that the efficiency of the conversion boiler may be substantially increased by baffling its large flue passages with firebrick.

Further efficiency of fuel oil may be obtained by using the smallest nozzle size able to deliver the required output. An additional 3 to 7% saving of oil is made when combustion chambers are constructed with insulating firebrick rather than standard firebrick, the tests reveal.

Station Engineers Cleghorn and Helfinstine, who conducted the research, found that the highest efficiency as far as combustion-chamber dimensions are concerned is attained when chamber dimensions approximate those recommended by the burner manufacturer.

The effect of cycling rate upon fuel economy apparently is not great. No single cycling rate was found which was most efficient for all burners and boilers. The rate of 1 cycle per hour was most efficient for one burner tested, and one cycle every 2 hours proved the most efficient for another.

[*"Performance of Pressure-Type Oil Burners," by M. P. Cleghorn and R. J. Helfinstine. Size, 6 x 9 in.; 32 pages. Obtainable free copies from Iowa Engineering Experiment Station, Iowa State College, Ames, Iowa.*]

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Marks' Handbook

The fourth edition of Marks' Mechanical Engineers' Handbook has recently appeared. This book contains 16 sections of which several are of particular interest to heating and ventilating engineers. Among these are: a chapter on mixture of air gases and vapors covering psychrometry, prepared by Prof. C. H. Berry of Harvard; a chapter on heat transmission by Prof. Wm. H. McAdams of M.I.T.; one on pipe and fittings by Prof. C. W. Ham of the University of Illinois; one on heating and ventilation by F. R. Ellis, lecturer on that subject at Harvard; one on air conditioning by Dr. Willis H. Carrier; one on ventilation and propeller fans by H. F. Hagen, research manager of B. F. Sturtevant Co.; and one on mechanical refrigeration by Frank L. Fairbanks, recently of Quincy Market Cold Storage & Warehouse Co.

[*"Marks' Mechanical Engineers' Handbook," fourth edition. Published by McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York. Cloth bound; 4½ x 7 in.; 2276 pages. Price, $7.*]

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Engineering Statistics

The aim of this book is to enable the engineer to employ statistical methods in quality control of manufacture. It provides simple but effective rules for the conduct of sampling and inspection in quantity production, and some entirely new and useful statistical charts, all supported by sound technical analysis. With a minimum of change in present methods, these statistical methods can be applied to bring about greater ease and efficiency of production.

No advanced mathematics is required to understand and apply the principles set forth. Its exposition of powerful scientific principles is made in clear, concise, engineering terms. It makes possible prompt, valid and consistent solutions of perplexing problems by means of figures and charts, and without the necessity of complicated mathematics and computational labor.

[*"An Engineers' Manual of Statistical Methods," by Major Leslie E. Simon. 6¾ x 9¾ in.; 232 pages, cloth bound. Published by John Wiley & Sons, Inc., 440 Fourth Ave., New York. Price, $2.75.*]

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Engineering Encyclopedia

The Engineering Encyclopedia supplies, in condensed form, the essential facts about 4500 standard and special engineering subjects. Although intended primarily for reference purposes, the Encyclopedia is designed to give students, whether young or old, a broad fund of knowledge relating to the outstanding subjects in many different branches of engineering. Because of the scope and miscellaneous character of this two-volume work, it is, of course, impossible to describe adequately the contents. In general, this Encyclopedia consists of concise treatises ranging from short paragraphs to several pages in length. These deal with various important mechanical laws, rules, and principles; physical properties and compositions of a large variety of materials used in engineering practice; the characteristic features

and functions of different types of machine tools and other classes of manufacturing equipment; and so many other subjects that a mere list would occupy thirty-six pages of this magazine if set double column in type of this size and allowing one line per subject. These condensed treatises are accompanied by definitions of numerous trade and technical terms used in engineering and manufacturing practice.

All matter is arranged alphabetically under the heading or word likely to be referred to, thus making the Encyclopedia self-indexing. Whenever a subject might properly be placed under more than one heading, such additional headings are included with suitable cross references. There are also many cross references to whatever subjects may be closely allied to any given subject. While it obviously is impossible to cover every conceivable subject, this work of reference is unusual in its scope.

[*"Engineering Encyclopedia." Two volumes, 6 by 9 in.; 1431 pages; 206 illustrations. Published by The Industrial Press, 148 Lafayette St., New York City. Price, $8.*]

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BRIEF REVIEWS

STANDARDS. A looseleaf assembly of equipment standards adopted by the Air Conditioning and Refrigerating Machinery Association, Inc., and made up of seven separate publications which can also be purchased individually. Each of the standards includes such information as nomenclature, information on construction and performance, and similar data. [*"Equipment Standards" of the Air Conditioning and Refrigerating Machinery Association, Inc., containing seven publications, price, $1.50. Individual publications may be ordered as follows: "Ammonia Compressors and Condensing Units," 8 pages, price, 40 cents; "Ammonia Condensers and Receivers," 11 pages, price, 50 cents; "Ammonia Brine Coolers," 10 pages, price, 40 cents; "Miscellaneous Ammonia Standards," 8 pages, price, 25 cents; "Self-Contained Air Conditioning Units," 5 pages, price, 35 cents; "Freon-12 Condensers and Receivers," 5 pages, price, 35 cents; and "Miscellaneous Freon-12 Standards," 7 pages, price, 25 cents. Published by Air Conditioning and Refrigerating Machinery Association, Inc., Southern Building, Washington, D. C.*]

AIR RAID SHELTERS. A British article on the control of air-borne infection in air-raid shelters and elsewhere. Reports that the most effective control measures are adequate spacing of individuals and ventilation. Ultraviolet light proved effective against bacteria in droplet nuclei but more so against dust-borne organisms. Air forced through a dust-retaining cloth filter and then over ultraviolet lamps was found to be almost free from bacteria. [*"Control of Air-Borne Infection in Air-Raid Shelters and Elsewhere," by C. H. Andrews. Published in The Lancet, 7 Adam St., Adelphi, WC2, London, England, 239, No. 6126 770-774, Dec. 21, 1940.*]

STOKERS. The second of a series of booklets covering the findings of the Koppers research program on stokers and stoker coal. This second booklet thoroughly discusses the effect of air regulation on domestic bituminous stoker performance. It is confined to bituminous burning stokers. Booklet includes a description of the investigation and a thorough-going statement of results based on continuous, intermittent and hold-fire firing. Clinker formation is also extensively treated. A feature of the bulletin is the close-up photograph showing the appearance of the fuel bed during tests with different air settings. The booklet concludes that the investigation shows that an air setting that gives abou 30% excess air on continuous running gives the best efficiency, heating power, clinker formation and other advantages. [*"Effect of Air Regulation on Domestic Stoker Performance—Booklet No. 2, Stoker Coal Research Program, The Koppers Coal Company." 4 x 7 in.; 32 pages; paper cover. Available without charge from The Koppers Coal Company, Pittsburgh, Pa.*]

ACOUSTICS. Two comprehensive mimeographed publications of the National Bureau of Standards, one on Classification of Acoustic Materials and one on Sound Absorption Coefficients of the More Common Acoustic Materials. The former, 19 pages, groups acoustical materials depending on the type of mounting and gives the trade name and description of the material, noise coefficient, name of manufacturer and thickness and, in the case of pre-fabricated units, gives the weight and fire resistance as well. The second publication, 27 pages, gives the sound absorption coefficients of acoustical materials and classifies by manufacturer; gives various other data as well. [*"Classification Of Acoustic Materials," published by National Bureau of Standards. 19 mimeographed sheets. "Sound Absorption Coefficients of the More Common Acoustic Materials," published by National Bureau of Standards. 27 mimeographed sheets. Available on request.*]

DEGREE DAY LOG. A spirally bound publication containing a page for each month for the 1941-42 heating system and providing space for entering for each day the number of degree days in the previous year, gallon figures, date, degree days on that date, and cumulative degree days up to that date, so that the user can post oil consumption figures in a convenient and permanent record. Also provided is a form for filling in the normal degree days by months for the user's area and a tank chart showing the amount of oil in different sized tanks for various depths. [*"Degree Day Log." 4½ x 7¾ in., paper cover. Available from Degree Day Systems, 57 West 42nd St., New York. Price, $1.*]

GARAGE VENTILATION. Description of a method used in a Lewistown, Pa., garage to remove carbon monoxide fumes. Method was to connect hose to engine's exhaust pipe at one end and to a duct at the other end, with duct leading outdoors. [*"Safe Practice Bulletin No. 32—Occupational Disease Prevention." Published by Department of Labor and Industry, Commonwealth of Pennsylvania. Paper cover; 8 x 10½ in.; 6 pages.*]

(Continued on page 68)

NEWS OF THE MONTH

Stoker Course for New England

BOSTON—Under the auspices of the Mass. State Department of Education, Division of University Extension, an anthracite stoker course will be presented at Massachusetts Institute of Technology, Cambridge, over a period of sixteen weeks beginning October 16. Allen H. Bearse, Jr., New England manager for Anthracite Industries, Inc., will handle the lectures.

The purpose of this course is to provide with the minimum of technicalities a study sufficiently broad and detailed to cover all elements entering into stoker performance. All graduates will be qualified to determine proper sizing of stokers for any domestic or apartment house heating installation; to check heating systems; detect faults that would prevent proper stoker performance; to prescribe appropriate remedies to faulty systems; to install and adjust any make of Anthracite stoker; to use instruments and other accurate means of checking stoker performance; to compute probable fuel consumption for any individual job; to select appropriate controls and to adjust the setting of controls for any type of installation.

The course includes specialized knowledge that will be of immense benefit not only to engineers, but also to management, salesmen, fuel dealers and their personnel, heating contractors, service and installation men as well as sales engineers.

The cost is $9 and further information can be obtained from the Division of University Extension, 200 Newberry Street, Boston, Mass.

Refrigerant Inventor Honored

ATLANTIC CITY—In recognition of his contributions to the development of refrigerants used in air conditioning, his discovery of tetra-ethyl lead as an anti-knock agent in gasoline and other chemical achievements, Dr. Thomas Midgley, Jr., was awarded the Priestley Medal of the American Chemical Society during its 102nd meeting, held here Sept. 8-12.

In an address accepting the medal, which is given once every three years for outstanding achievement in chemical science and is the highest honor bestowed by the society, Dr. Midgley gave a demonstration of the non-toxic, non-inflammable properties of certain organic fluorides largely responsible for a great portion of the air conditioning industry, and also reviewed other spectacular industrial developments arising from research with which he has been associated during the past 20 years.

Carrier Rates Navy "E" Pennant

SYRACUSE—Carrier Corporation was presented with the Navy Ordnance flag and the Navy E pennant at ceremonies held here Sept. 11. Assistant Secretary of the Navy Ralph A. Bard made the presentation.

Carrier is the fifteenth industrial organization in the country to receive the right to fly these flags which are awarded to manufacturing concerns which have a rating of outstanding performance in production from the Bureau of Ordnance. The letter E will appear in white upon a blue pennant to fly below the Ordance flag on the factory flagstaff. Employees will wear a lapel badge which bears an E.

Fan Building Design Accepted

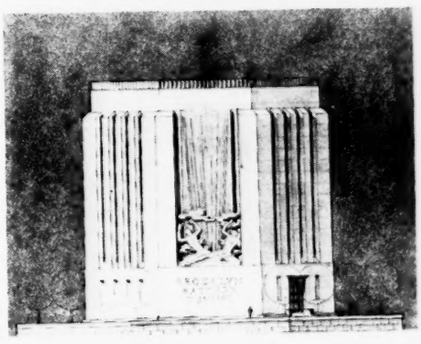
NEW YORK—The architectural design for the exterior of the Brooklyn-Battery Tunnel mid-river ventilation building adjacent to Governors Island has been made public by the New York City Tunnel Authority, which announced that McKim, Mead & White had won first prize of $2,000 in the Authority's competition for the best design for the structure.

The design contemplates a structure 125.6 feet high, or the equivalent of twelve stories. Its diameter is only a few feet less than its altitude. It will be half as large again as the pedestal of the Statue of Liberty across the bay, which is eighty-nine feet high and sixty-two feet wide at the base.

Construction of the shaft for the tunnel will be started next December and the shaft is scheduled for completion in time for construction on the ventilation building to be started in November of next year.

The structure will house twelve large fans for the intake of fresh air and as many for the exhaust of vitiated air. Together with the fans in the two other ventilation buildings, one situated in Brooklyn and the other in Battery Park, they will supply a maximum of 4,150,000 cfm.

Right, prize winning design for the Brooklyn Battery Tunnel. Below, north elevation.



Factory Building at All-Time High

WASHINGTON—Due to the demands of the defense program, approximately $4,900,000,000 will be invested in new manufacturing plants and equipment this year, by far the largest expenditure in our history, Lowell J. Chawner, chief industrial economist of the Commerce Department, estimates. In 1940, expenditures for plant and equipment totaled $2,303,000,000, and in 1920—the previous peak—they were $3,165,000,000.

Principal items include the following: Airplanes, motors and parts, $700,000,000; chemicals, including powder, $580,000,000; shipbuilding, $550,000,000; ammunition, shells and bombs, $480,000,000, and guns and small arms, $280,000,000.

In addition to the investment in plants manufacturing munitions and military equipment, it is estimated that $1,310,000,000 will be spent in expanding industrial facilities closely related to defense. Indicated expenditures of this type include the following: Iron and steel, $500,000,000; non-ferrous metals, $300,000,000; petroleum products and coal, $250,000,000, and machinery, including electrical products, $260,000,000.

FHA Authorization Upped

WASHINGTON — President Roosevelt has now signed a bill to increase by $200,000,000 the Federal Housing Administration's authorization to insure loans financing privately-built defense housing in designated areas where shortages are threatening to impede the defense production program.

Armspach Opens Own Office

CHICAGO—Otto W. Armspach, formerly with Kroeschell Engineering Company, has opened an office for the practice of mechanical engineering at 221 No. LaSalle St. Mr. Armspach, a pioneer engineer in the air conditioning field, will specialize in air conditioning, ventilating and heating.

Air-Borne Spores, Bacteria and Insects Subject of Discussion at Symposium on Aerobiology, A New Science

CHICAGO—A symposium on aerobiology, a new science dealing with the presence and migrations of bacteria and spores in the air, was held under the auspices of the Medical Section of the American Association for the Advancement of Science and the Committee on Aerobiology of the National Research Council in connection with the fiftieth anniversary celebration of the University of Chicago Sept. 22.

It was brought out at the symposium that plant spores which cause hay fever and other allergic ailments travel over the nation in huge "clouds" more than 10,000 feet above the ground, fall to the earth in "showers" and often produce "spore storms."

These observations, based partly upon research made from airplanes, were described by Dr. Oren C. Durham of the Abbott Laboratories, North Chicago, who spoke on "air-borne fungus spores as allergens."

Discussing airplane research on the atmospheric distribution of fungus spores, Dr. Durham said that they were relatively abundant up to 11,000 feet, although there was a marked thinning out at 6,000 feet.

During the spore shower of Oct. 6 and 7, 1937, the largest in thirteen years, thousands of tons of alternaria and normodendrum, fungus spores, were transported several hundred miles, he said.

Air currents, temperature and barometric pressure play an important part in disseminating insects, bacteria and such plant diseases as rust, it was stated at the symposium.

Bacteria are less abundant in marine air, rain and snow than in air masses of continental origin, according to investigations reported by Claude E. Zobell of the Scripps Institute of Oceanography, University of California.

The ratio of bacteria over oceans as compared with those over land, he said, might be about 1 to 250.

A bacterium would be carried nearly 3,000 miles by a steady 10-mile wind before it would fall to earth from a height of 100 feet, he said.

Though many bacteria in the air are killed almost immediately by sunlight, desiccation and other adverse conditions, marine bacteria are known to survive suspended in the atmosphere for several hours, he said, and terrestrial bacteria found over the ocean hundreds of miles from land necessarily must have been in the air for as long as a few weeks.

Plant spores, such as rust, produced in astronomic numbers, are carried over wide areas by the wind, making control of plant disease difficult, Dr. J. J. Christensen, Professor of Plant Pathology at the University of Minnesota, reported.

Spores have been found as high as three miles in the air, he stated, and high winds, gales, cyclones carry enormous numbers of these pathogenes to considerable heights. Because they fall slowly, the spores can be carried thousands of miles by air currents to infect crops.

Computations made for all seasons of the year as to the number of insects in a column of air one mile square, starting at fifty feet above the earth's surface and extending to 14,000 feet, indicate an approximate average of 25,000,000 insects, Perry A. Glick of the Bureau of Entomology and Plant Quarantine, Department of Agriculture, told the meeting.

Install Panel Heat Test Room

BERKELEY, CALIF.—The University of California has completed the installation of a panel heating test room for use of the mechanical engineering department in experiments in panel heating. The experimental work will be conducted under the direction of Professors B. F. Raber and F. W. Hutchinson, of the mechanical engineering department.

PLASTIC MOLD FOR FAN BLADES

The longest mold ever made by the plastics department of the General Electric Company is being used at West Lynn, Mass., to produce fan blades formerly made of metals. The fan blades, four and a half feet long, are for the Foster Wheeler Corporation for cooling tower fans. A molded plastic fan blade is important at this time because of the need of metals formerly used, such as aluminum and magnesium, for defense. The plastic blade is lighter than the metal blades it replaces, but is of about equal strength.

Industrial Practice Discussed

LA CROSSE—Wars are looked upon as great tradition breakers in the building construction and equipment field, F. O. Jordan, Detroit, engineer with Albert Kahn and Associates, told the local chapter of the ASHVE at a banquet at the Hotel Stoddard here September 6. More than seventy members from Minnesota, Iowa and Wisconsin were guests during the day and evening of The Trane Company. The visitors toured the Trane factories.

"Tradition can be a danger because if it crystallizes too far it eliminates improvement and advancement," Mr. Jordan told his audience. "War forces the adoption of new ideas," he emphasized. "In the past wars were fought on the fringes of nations by human beings, with death and destruction not extending to the interior.

"Now wars are fought by machines of long range. The nation with the most and best machines probably will win. For that reason it is essential to keep production at a high peak."

He traced the evolution of building construction, pointing out that industrial plants now largely are on one floor. These have been developed so they can be blacked out in case of war, Mr. Jordan said.

"If production must be carried on to win a war, it is necessary to take certain precautions to protect buildings against possible bombing," he declared. "There are two types of buildings that can be blacked out. One has windows from which interior light can be blocked out, while the other has no windows at all."

The speaker cited several individual examples of new industrial construction falling into these categories. He told of methods of preventing the heat from entering such buildings, as well as ways of removing it.

Under the prevention system are insulation, reflecting colors, spraying roofs with water, shading windows and the use of sun resistant glass, while under heat removal come changing the air, evaporative cooling, use of well water and actual refrigeration for air conditioning.

Mr. Jordan predicted a rapid growth in air conditioning after the war and pointed out that the national defense program and the war are emphasizing the importance of air conditioning in industrial plants.

Boston Utility Surveys Heating

BOSTON—A survey is being conducted by the power sales staff of the Boston Edison Company of all classes of industrial heating applications in its territory, to obtain data useful in defense work, load building and improving customer service.

(News continued on page 60)

FREQUENCY OF LOW DAILY TEMPERATURES

AVERAGE FREQUENCY OF RECURRENCE OF DAILY MEAN AND DAILY MINIMUM TEMPERATURES

(Showing the average number of times that daily temperatures have been as low as or lower than the temperatures indicated)

STATE AND CITY	AVERAGE FREQUENCY OF RECURRENCE															
	Once in 3 Years		Once in 2 Years		Once per Year		Twice per Year		3 Times per Year		4 Times per Year		5 Times per Year	
	TEMPERATURES, F													
	Minimum	Mean	Minimum	Mean	Minimum	Mean	Minimum	Mean	Minimum	Mean	Minimum	Mean	Minimum	Mean
ALABAMA														
Birmingham	7	16	8	18	11	21	15	25	17	26	19	28	20	29
Mobile	18	27	19	28	22	30	24	33	27	35	28	36	29	38
ARIZONA														
Flagstaff	-18	2	-17	3	-14	6	-11	8	-8	10	-6	12	-5	13
Phoenix	24	38	25	39	26	40	27	41	28	42	29	43	29	43
Yuma	29	39	29	40	30	42	31	44	32	45	33	46	33	46
ARKANSAS														
Fort Smith	-3	9	1	12	5	15	9	18	12	21	14	22	15	23
Little Rock	5	13	6	15	9	18	12	20	14	22	16	23	18	25
CALIFORNIA														
Eureka	25	33	27	34	28	36	29	37	31	38	31	39	32	39
Fresno	24	32	25	33	27	35	28	36	29	37	29	38	30	38
Los Angeles	35	42	36	42	37	43	38	45	39	46	40	47	40	47
San Francisco	33	38	34	39	35	40	36	41	37	42	38	43	39	44
COLORADO														
Denver	-16	-7	-14	-6	-11	-3	-8	1	-5	5	-3	7	-1	9
Durango	-19	0	-18	1	-15	3	-12	6	-10	8	-8	9	-7	10
Grand Junction	-17	-1	-16	0	-12	2	-9	4	-6	7	-4	9	-2	10
Trinidad	-18	-2	-16	1	-9	4	-5	9	-3	11	-1	13	0	15
CONNECTICUT														
New Haven	-8	1	-6	3	-3	7	1	10	3	12	5	13	6	14
FLORIDA														
Jacksonville	21	30	22	32	25	35	28	37	30	39	31	40	32	41
Tampa	28	40	30	40	33	43	35	45	36	46	37	47	38	48
GEORGIA														
Atlanta	5	15	6	16	11	20	14	23	16	26	18	27	19	27
Savannah	18	26	20	28	22	32	25	35	27	36	28	37	29	38
IDAHO														
Lewiston	-15	-4	-13	-3	-10	0	-5	4	0	8	3	11	5	12
Pocatello	-20	-9	-18	-8	-16	-6	-11	-1	-8	3	-6	5	-4	7
ILLINOIS														
Cairo	-4	4	-2	5	1	9	4	12	7	14	9	16	10	18
Chicago	-14	-6	-13	-5	-9	-1	-6	1	-5	3	-3	5	-2	6
Springfield	-15	-5	-13	-3	-8	0	-5	3	-3	5	-2	6	0	8
INDIANA														
Evansville	-7	1	-5	3	-1	6	2	10	4	12	6	14	7	15
Fort Wayne	-14	-2	-12	-1	-8	1	-6	3	-5	5	-3	6	-1	7
Indianapolis	-11	-2	-10	-1	-8	2	-4	5	-3	7	-1	8	0	10
IOWA														
Dubuque	-24	-11	-22	-10	-18	-8	-15	-5	-13	-3	-10	-2	-9	-1
Keokuk	-18	-8	-17	-7	-13	-3	-9	0	-7	2	-5	4	-4	5
Sioux City	-24	-16	-23	-15	-20	-11	-16	-8	-14	-6	-12	-3	-11	-3
KANSAS														
Concordia	-15	-6	-14	-5	-10	-2	-8	2	-5	3	-3	5	-2	6
Dodge City	-12	-3	-11	-2	-9	1	-6	5	-4	7	-1	9	0	10
Goodland	-17	-9	-16	-7	-14	-3	-10	1	-7	4	-6	6	-5	8
Wichita	-10	-1	-8	0	-6	3	-2	6	1	9	2	11	3	12
KENTUCKY														
Lexington	-8	1	-6	2	-4	5	0	8	2	10	4	13	6	15
LOUISIANA														
New Orleans	22	28	23	30	26	33	29	36	31	37	32	39	33	40
Shreveport	11	21	13	22	16	25	19	26	21	28	23	30	24	31
MAINE														
Eastport	-17	-10	-16	-7	-12	-4	-10	0	-7	1	-6	3	-5	4
Portland	-14	-5	-12	-3	-9	1	-6	3	-4	5	-2	6	-1	8
Van Buren	-42	-23	-41	-22	-37	-19	-34	-15	-32	-13	-30	-11	-28	-10
MARYLAND														
Baltimore	2	10	4	11	6	14	9	16	10	18	12	19	13	20
Cumberland	-6	6	-5	7	-2	10	1	12	4	14	5	15	6	17
MASSACHUSETTS														
Boston	-10	0	-7	2	-3	5	0	9	2	11	3	12	4	14
MICHIGAN														
Alpena	-18	-8	-17	-6	-13	-4	-10	-1	-9	1	-8	2	-7	3
Detroit	-10	-1	-9	0	-5	2	-3	5	-1	6	0	8	1	9
Grand Rapids	-11	-1	-10	0	-7	2	-2	5	-1	7	0	8	1	9
Marquette	-18	-10	-17	-9	-14	-6	-12	-4	-10	-2	-9	-1	-8	0
MINNESOTA														
Duluth	-33	-23	-32	-22	-29	-20	-26	-16	-25	-14	-23	-13	-22	-12
Minneapolis	-27	-19	-25	-18	-23	-15	-20	-12	-18	-10	-17	-8	-16	-7
Moorhead	-35	-25	-32	-24	-31	-22	-28	-18	-26	-16	-24	-15	-23	-14
MISSISSIPPI														
Vicksburg	11	20	13	22	16	24	20	27	21	29	23	31	24	32
MISSOURI														
St. Joseph	-16	-7	-15	-6	-12	-3	-9	0	-6	2	-4	4	-2	6
St. Louis	-10	-1	-8	1	-3	4	0	8	2	10	3	11	5	13
Springfield	-11	-1	-9	0	-5	4	-1	8	1	11	3	12	5	13
MONTANA														
Billings	-36	-23	-34	-22	-31	-19	-26	-14	-22	-11	-20	-9	-18	-7
Havre	-42	-31	-39	-29	-36	-26	-33	-23	-30	-20	-28	-17	-26	-15
Helena	-32	-25	-31	-24	-29	-21	-25	-17	-22	-13	-20	-11	-17	-8
Kalispell	-26	-16	-25	-16	-22	-13	-18	-10	-16	-7	-13	-5	-11	-3
NEBRASKA														
Lincoln	-20	-10	-18	-9	-16	-6	-13	-3	-10	-1	-9	0	-7	1
North Platte	-22	-12	-21	-10	-18	-8	-15	-4	-12	-2	-11	0	-10	1

STATE AND CITY	AVERAGE FREQUENCY OF RECURRENCE															
	Once in 3 Years		Once in 2 Years		Once per Year		Twice per Year		3 Times per Year		4 Times per Year		5 Times per Year	
	TEMPERATURES, F													
	Minimum	Mean	Minimum	Mean	Minimum	Mean	Minimum	Mean	Minimum	Mean	Minimum	Mean	Minimum	Mean
NEVADA														
Logandale	14	28	14	29	16	31	19	32	20	34	21	35	21	36
Reno	-10	5	-7	7	-3	9	0	13	2	15	5	17	7	18
Searchlight	14	22	15	23	17	25	20	28	22	30	23	31	24	32
Tonopah	-5	2	-4	4	2	9	4	11	7	13	8	14	9	15
Winnemucca	-25	-8	-24	-6	-19	-1	-13	4	-8	8	-6	10	-5	11
NEW HAMPSHIRE														
Concord	-20	-8	-18	-6	-16	-1	-12	1	-10	3	-8	5	-7	6
NEW JERSEY														
Atlantic City	0	9	1	10	4	13	7	16	9	18	11	19	12	20
NEW MEXICO														
Roswell	-4	9	-2	10	2	14	6	18	9	20	10	22	12	23
Santa Fe	-3	7	-2	9	0	11	2	13	4	15	5	16	6	17
NEW YORK														
Albany	-18	-9	-16	-7	-12	-2	-8	2	-6	4	-4	6	-3	7
Buffalo	-8	-3	-7	-1	-5	3	-2	5	-1	7	0	8	2	9
New York	-6	4	-3	6	0	10	4	12	6	14	7	15	8	17
NORTH CAROLINA														
Asheville	-2	9	-1	10	3	11	7	17	9	19	11	21	12	22
Raleigh	8	16	8	18	11	20	14	23	15	24	17	25	18	26
Wilmington	12	21	13	23	16	25	19	28	21	30	23	31	24	32
NORTH DAKOTA														
Bismarck	-39	-27	-37	-25	-33	-22	-29	-20	-27	-17	-26	-16	-25	-14
Devil's Lake	-40	-30	-38	-29	-35	-26	-32	-23	-30	-21	-28	-20	-27	-19
Williston	-39	-29	-37	-27	-34	-24	-31	-22	-29	-20	-27	-19	-26	-18
OHIO														
Cincinnati	-10	0	-9	1	-5	3	-2	6	0	9	2	11	3	12
Cleveland	-7	1	-6	2	-4	4	-1	7	0	8	2	9	3	10
Columbus	-9	0	-9	0	-7	3	-2	6	0	8	1	10	3	11
OKLAHOMA														
Oklahoma City	-4	4	-2	5	1	8	4	12	7	15	9	16	10	18
OREGON														
Baker	-21	-8	-19	-7	-15	-3	-11	1	-8	4	-5	6	-4	7
Medford	3	15	6	16	9	20	13	24	15	26	17	27	18	28
Portland	11	15	12	16	14	19	16	21	18	22	19	24	21	25
PENNSYLVANIA														
Philadelphia	1	9	2	10	4	12	8	15	10	17	11	18	12	19
Pittsburgh	-7	1	-6	2	-4	4	-1	7	1	9	3	11	5	12
Scranton	-9	0	-7	3	-5	5	-1	8	1	9	2	10	3	11
Somerset	-20	-4	-17	-3	-14	0	-10	3	-8	6	-6	8	-4	9
RHODE ISLAND														
Providence	-8	0	-6	2	-2	6	0	9	3	11	4	12	5	13
SOUTH CAROLINA														
Charleston	17	23	18	25	22	29	25	33	27	34	28	35	29	36
Columbia	12	21	13	22	16	26	19	28	21	30	22	31	24	32
SOUTH DAKOTA														
Huron	-31	-21	-29	-19	-26	-16	-23	-14	-22	-12	-20	-10	-18	-9
Rapid City	-28	-19	-27	-18	-24	-15	-21	-12	-18	-9	-17	-7	-15	-6
TENNESSEE														
Knoxville	2	9	3	11	6	14	9	19	12	21	14	23	15	24
Memphis	5	11	6	12	8	15	11	18	14	20	15	22	16	23
TEXAS														
Amarillo	-5	4	-4	5	-2	7	1	13	4	15	6	17	8	18
Brownsville	25	32	26	35	30	37	31	39	33	40	34	42	35	43
El Paso	14	25	16	25	18	27	19	30	21	32	22	33	23	34
Fort Worth	7	16	10	18	12	21	15	23	17	26	18	27	19	28
San Antonio	17	22	18	25	21	29	24	32	25	34	26	35	27	36
UTAH														
Modena	-23	-9	-22	-6	-17	-2	-13	2	-11	5	-9	6	-7	9
Salt Lake City	-8	1	-6	2	-2	7	3	12	5	14	7	15	8	16
VERMONT														
Burlington	-25	-17	-23	-13	-19	-8	-16	-6	-14	-3	-12	-2	-11	-1
VIRGINIA														
Lynchburg	0	13	2	14	4	15	8	18	9	20	11	22	13	23
Norfolk	9	16	10	17	13	20	16	22	17	24	19	26	20	27
Wytheville	-5	5	-4	6	-1	9	2	12	5	14	6	16	8	17
WASHINGTON														
Seattle	14	19	15	20	17	23	19	24	21	26	23	28	24	29
Spokane	-15	-3	-13	-2	-9	0	-7	2	-4	5	-1	7	1	9
Yakima	-14	-1	-11	1	-8	3	-4	5	0	7	1	10	3	11
WEST VIRGINIA														
Elkins	-14	0	-11	1	-8	3	-5	6	-3	8	-1	10	1	12
Parkersburg	-9	3	-7	4	-3	6	0	9	2	12	4	13	5	15
WISCONSIN														
Green Bay	-24	-13	-23	-12	-20	-10	-17	-8	-15	-6	-14	-4	-12	-3
LaCrosse	-27	-16	-26	-15	-24	-12	-21	-9	-18	-7	-16	-6	-15	-5
Milwaukee	-18	-10	-16	-9	-14	-5	-11	-3	-9	-1	-7	0	-6	2
WYOMING														
Encampment	-30	-12	-26	-11	-22	-6	-17	-1	-14	1	-12	4	-10	5
Lander	-36	-22	-34	-20	-27	-16	-23	-12	-21	-9	-19	-7	-18	-5
Sheridan	-35	-22	-33	-21	-29	-19	-25	-14	-23	-11	-21	-9	-19	-7
Yellowstone Park	-34	-24	-33	-22	-29	-18	-25	-13	-20	-9	-18	-6	-16	-4

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H. & V.'s REFERENCE DATA — 207

FREQUENCY OF LOW DAILY TEMPERATURES

The proper design temperature for winter heating installations cannot economically be the lowest reported temperature in the given locality, inasmuch as the lowest temperature is reached only once in a long period of years. A standard rule for selecting the design temperature is that it should be not more than 15F above the lowest recorded temperature, but a more specific delimiting has never been widely adopted.

In order to provide a basis for selecting heating design temperatures, an analysis of weather in 120 cities was made by Professor Clark M. Humphreys of Carnegie Institute of Technology. In making his study, he selected 23 years as the average number of years' data on which to base his study. The study included analysis of both daily minimum and daily mean temperatures, and the analysis of both are shown in the table on the opposite side of this sheet.

This table shows the average number of times per year, during the period studied, that the daily minimum and daily mean temperatures were as low as or lower than the temperature indicated in the body of the table. Frequency of recurrence ranging from once in three years to five times in one year is included.

As an example of the use of this table it is shown that in Birmingham, Ala., a daily minimum temperature of 8F or lower occurred on an average of once every two years. A daily mean temperature of 18F or lower occurred with the same frequency. A daily mean temperature of 17F occurred on an average of three times per year and a daily mean temperature of 26F or lower occurred on an average of three times per year.

Conclusions from the study were that:

1. The daily mean temperature is a better indication of heating load than the daily minimum temperature. It is therefore a more logical basis for the determination of design temperature.

2. The design temperature should be based upon the probable frequency of recurrence of low temperatures, rather than upon the lowest daily mean or daily minimum temperature on record.

3. There is no one frequency of recurrence which should be used for the selection of all design temperatures. It will depend upon the type of building or the purpose for which it is to be used, upon the severity of the weather in the district in which the building will be built, and upon local weather peculiarities.

4. Any attempt to predict weather conditions in one city from weather data for another city should be made with caution.

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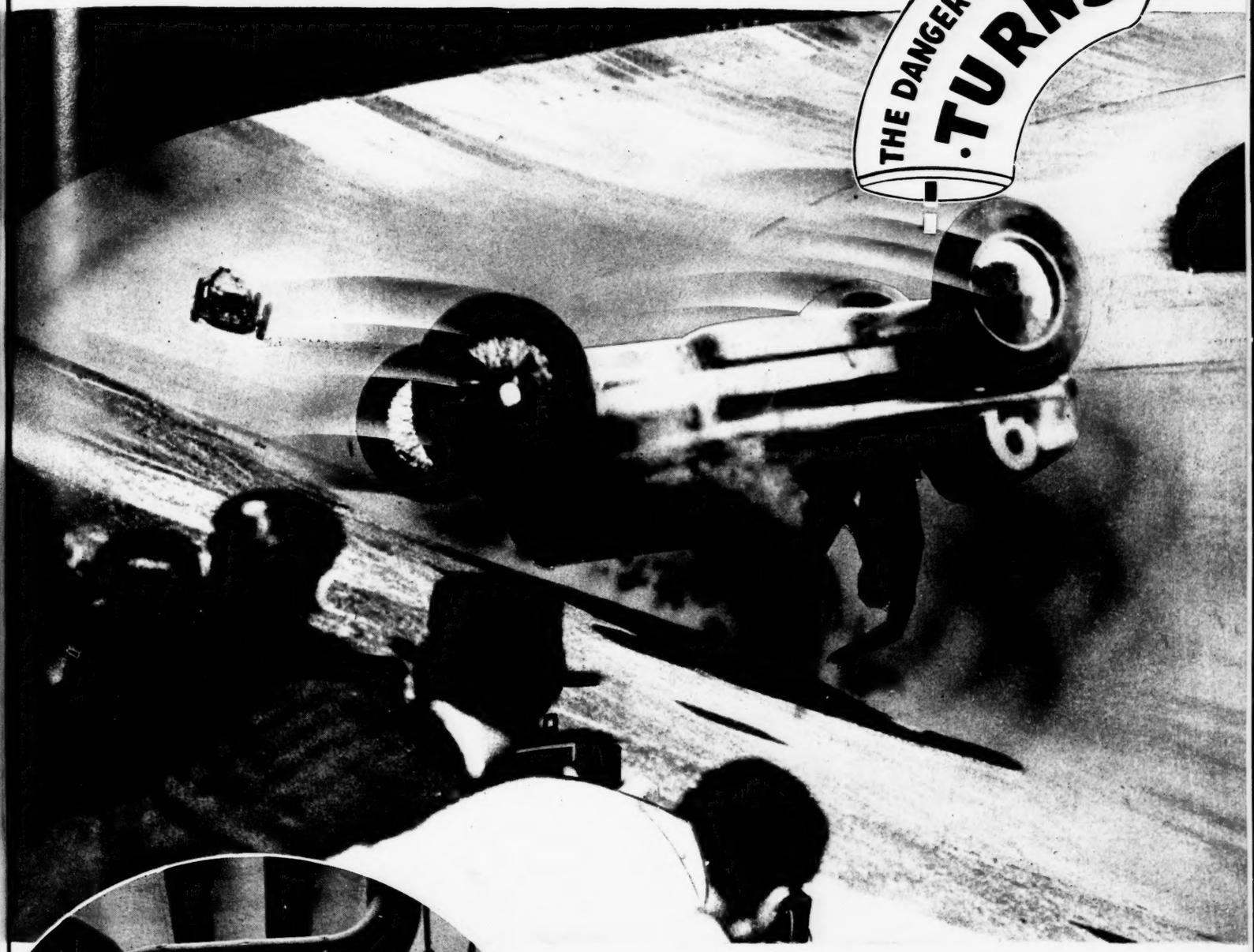
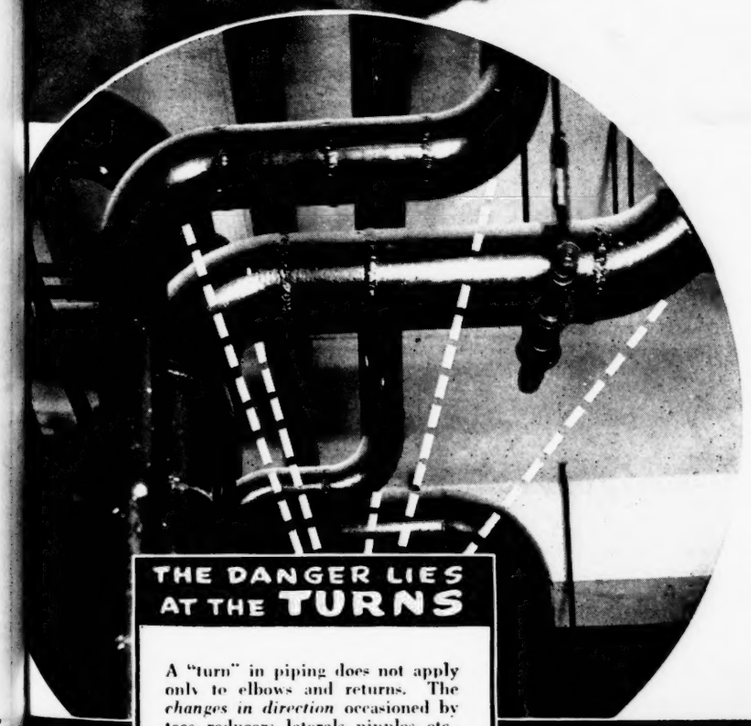
IN YOUR PIPING SYSTEMS, TOO . . .





THE DANGER LIES AT THE TURNS

A "turn" in piping does not apply only to elbows and returns. The *changes in direction* occasioned by tees, reducers, laterals, nipples, etc., make them "danger spots" as well, because of the extra friction and strain imposed on the abrupt turns within them. *Play safe* with Tube-Turns at *every* danger point.

Protect the "danger points" in your piping with TUBE-TURN welding fittings

The job of controlling the terrific power and mechanical strain in racing cars is *doubly intensified* AT THE TURNS.

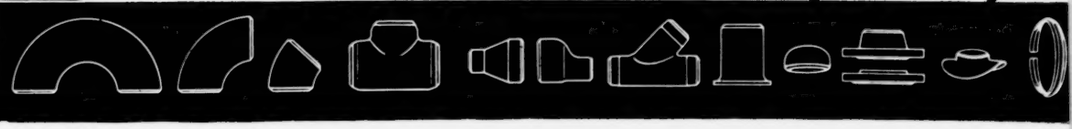
The most abuse, stress and wear in piping systems also occur *at the turns*—wherever there is a change in direction. Tube-Turns' exclusive construction—plus welding—insures the greatest possible strength, safety and leak-proof performance at these crucial points.

Prevent costly repairs and replacements in your piping system *before* trouble develops—by welding your lines with Tube-Turn fittings!

Write for helpful Tube-Turns catalog and data book.

TUBE-TURNS, Inc., Louisville, Ky. *Branch offices*: New York, Philadelphia, Chicago, Pittsburgh, Cleveland, Tulsa, Los Angeles. Distributors everywhere.

TUBE-TURN *Welding Fittings*
TRADE MARK



U. of P. Industrial Hygiene Course

PHILADELPHIA—In order to provide trained industrial hygienists to meet the needs of expanding health and safety services in the defense industries, the University of Pennsylvania will offer a twelve weeks' course of instruction in Industrial Hygiene.

The course will be given under the auspices of the Engineering, Science and Management Defense Training Program of the U. S. Office of Education and is open to graduates in engineering, chemistry or allied sciences.

Subjects covered in the course include: Principles of industrial hygiene industrial hygiene laboratory methods, industrial ventilation, safety engineering, administration of industrial health services, industrial psychology and statistical methods.

A minimum of ten students is required in order to give the course, which will run from October 27, 1941 to January 17, 1942. Applications for admission to the course should be addressed to: Theodore Hatch, Associate Professor of Industrial Hygiene, Department of Public Health and Preventive Medicine, University of Pennsylvania, Philadelphia, Pa.

60 to 80% of Fans Are for Defense

DETROIT—From 60 to 80% of the products manufactured by member companies of the National Association of Fan Manufacturers are now being furnished for defense projects. The application of fans and blowers for these purposes range from small ventilating blowers to protect an individual welder from toxic fumes to huge blowers handling 100,000 cfm at 65 inches pressure driven by a 1500 hp motor for the testing of airplanes.

Fans and blowers have been required for hull ventilation of battleships, cruisers, destroyers and cargo ships; in U. S. Army forts, camps and bases as well as for trucks and tanks; in mining smelting, aviation, chemical and powder industries; for rayon, silk, cotton and woolen mills; for power plants and many other special applications such as heat treating furnaces where the blowers handle gases at a temperature as high as 1600 deg. F. The Association will hold its next meeting in New York December 4.

L. W. Wallace Joins Trundle

CLEVELAND—L. W. Wallace, research and management engineer, has joined the staff of The Trundle Engineering Co., consulting engineers, as vice-president. Before accepting his new position Mr. Wallace was director of engineering and research of Crane Co., Chicago.

Robert E. Hattis, consulting engineer.

Hattis Moves to New Office

CHICAGO—Robert E. Hattis, consulting air conditioning, electrical, mechanical and power plant engineer, has moved his offices to the 43rd floor of the Board of Trade Building where he occupies the whole floor, a total of 3000 sq ft of space. The location of the offices at this height gives not only comfort and quiet but good light during all seasons. In addition, the office has exposure on three sides with cross ventilation.

A feature of the office is its division into smaller spaces with glass partitions so arranged that portions can be opened by means of transoms in order to facilitate the ventilation even though the rooms are sub-divided. These sub-spaces consist of a reception room, general office, three private offices and two drafting rooms.

Mr. Hattis invited friends from outside and within Chicago to visit his offices to inspect them and enjoy the unusual view of the city.

Butane Gas Use Increases

LOS ANGELES—Use of heating units designed to burn butane or some other form of liquefied gas is increasing so rapidly in residential districts being built in outlying sections of this city remote from natural gas lines of utility companies that the Board of Building and Safety has found it advisable to issue new regulations pertaining to such heating equipment.

Amended rulings were necessary, according to G. E. Morris, superintendent of buildings, because of the great difference in the characteristics between natural gas and liquefied petroleum. Safe and efficient performance of a heating unit, Morris pointed out, depends to a large extent on proper burner fire box construction and arrangement of the gas control equipment for the particular gas supplied to the heater.

Radiator Sizes Simplified

WASHINGTON—A revision of the simplified practice recommendation on large-tube cast-iron radiators has been approved by the industry and became effective October 1, further reducing the list of stocks, according to the Department of Commerce.

The revision, worked out by the industry in cooperation with the Division of Simplified Practice, National Bureau of Standards, will be identified as Simplified Practice Recommendation R174-41.

The original draft of this recommendation, dated March 1, 1940, established a simplified schedule of 17 recommended stock sizes of large-tube radiators out of a total of 33 sizes in production at that time. The current revision reduces the list of stock sizes to 13 by eliminating the following: 4-tube, 20-inch height; 6-tube, 20-inch height; 7-tube, 17-inch height, and 7-tube, 26-inch height.

John J. Nesbitt

PHILADELPHIA—John J. Nesbitt, president of John J. Nesbitt, Inc., Holmesburg, Philadelphia, manufacturers of heating, ventilating and air conditioning equipment, died at the Lankenau Hospital here September 11 at the age of 74.

In 1917 Mr. Nesbitt invented the school room unit ventilator which has met with wide acceptance.

He is survived by three sons, Albert J., Harry J. and John J. Nesbitt, Jr., and two daughters, Mrs. John McElgin and Mrs. Richard Thurber.

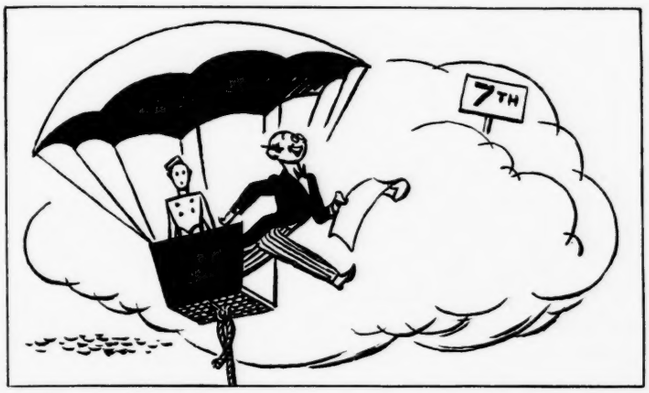
Clarence H. Kennedy

ELMIRA, N. Y.—Clarence H. Kennedy, vice-president in charge of sales, The Kennedy Valve Manufacturing Company, died here July 21 after an illness of eight months. Mr. Kennedy spent his entire public career with The Kennedy Valve Manufacturing Company which was founded by his father, Daniel Kennedy, in 1877.

Horatio B. Hackett

CHICAGO—Colonel Horatio B. Hackett, former assistant administrator and director of the Housing Division of PWA, died here Sept. 8 at the age of 61. In the World War he went overseas as colonel of the 124th Field Artillery. The Distinguished Service Medal and the Silver Star and Purple Heart decorations were conferred on him. After the War he was a member of the architectural and engineering firm of Holabird & Root. From March, 1938, to January, 1941, he was president of the Thompson-Starrett Company, Inc., New York builders, and more recently had been head of the Materials Service Corporation. He leaves a widow, Mrs. Winifred Marshall Hackett.

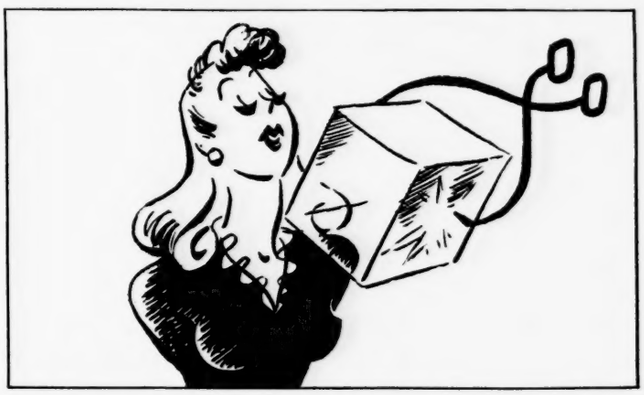
Here's the way to Laugh at Air Filter Troubles



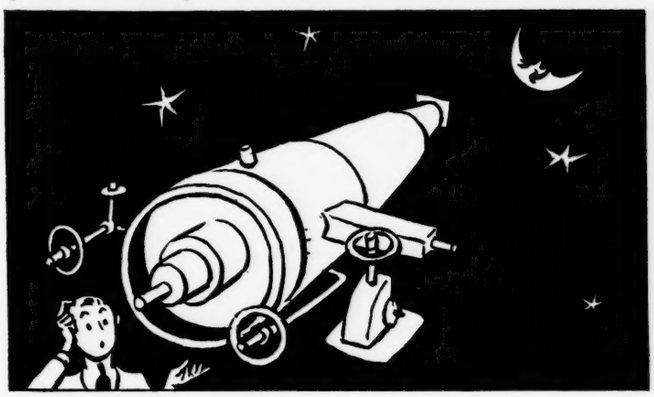
1. Fiberglas* Dust-Stop* Air Filters lift company treasurers to seventh heaven. They're so darn inexpensive! They cost only about 1¢ per CFM to install . . . complete! And one-tenth of a cent per CFM replaces the filters when they have to be changed. That's the first advantage . . . economy!

2. There's no need to lose your hair worrying over how much changing filters will cost you. Dust-Stops don't require expensive, special handling. Or any charging, washing, draining, etc. You won't have to bother with spares or skilled labor! That's the second big point—Dust-Stops give you *no* trouble on maintenance!

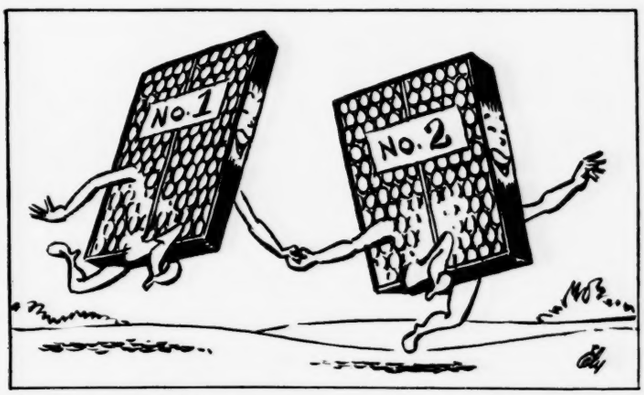
3. You'll be the toast of the company for years if you use Dust-Stops! They are so efficient . . . stopping practically all "nuisance" dusts! Capacity: 2 CFM per square inch of area at 300 FPM. Average resistance, new (in inches of water gauge): .062 for 1-inch; .13 for 2-inch Dust-Stops. That's the third plus . . . efficiency!



4. Dust-Stops give combustion the cold shoulder, too! The glass fiber filtering element will *not* support combustion. What a comfort that is! And that's the fourth fact to remember! What's more . . .



5. The strongest telescope can't detect any signs of bleeding from Dust-Stops! So don't give adhesive droplets on inside ducts or walls a second thought. That's the fifth thing you're looking for! Add all these grand features together and . . .



6. Order replaceable Dust-Stops . . . today! Get the five pluses you want in air filters! Order Dust-Stops from your air-conditioning manufacturer, dealer, or jobber. Or write us! They come in two thicknesses, No. 1 (1-inch) and No. 2 (2-inch). *Owens-Corning Fiberglas Corporation, Toledo, Ohio.*

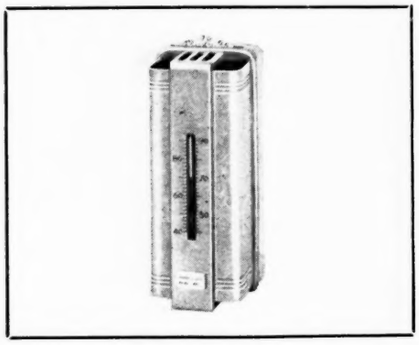
FIBERGLAS* DUSTOP* AIR FILTERS

*T.M. Reg. U. S. Pat. Off.

Made by Owens-Corning Fiberglas Corporation, Toledo, Ohio

DIRECT CANADIAN INQUIRIES TO FIBERGLAS CANADA LIMITED, OSHAWA, ONTARIO

NEW EQUIPMENT



M-H Acratherm thermostat.

Acratherm Thermostat

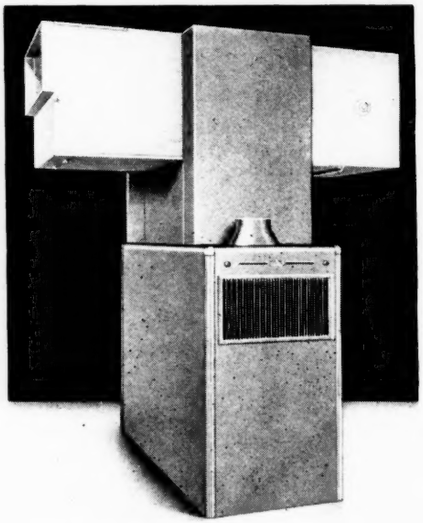
NAME—T81 Acratherm.
PURPOSE — For controlling two-wire low voltage valves and motors.
FEATURES — This new low voltage room thermostat is similar in design and appearance to the company's series 10 Acratherm except that single pole, single throw, snap action controls are used to permit control of two-wire devices. Accurate control is obtained through use of an artificial heater and a sensitive bi-metal actuating element. Differential is adjustable and contacts are of ample capacity for low voltage loads. Has silver finish, furnished with detachable mounting plate to facilitate installation. At no extra cost the device may be equipped with locking cover to guard against tampering and a positive night cutoff to prevent any operating of the heating plant during the night.
SIZES AND CAPACITIES—Standard range is 54 to 86F.
MADE BY — *Minneapolis-Honeywell Regulator Company, Minneapolis, Minn.*

Goodrich Vibro-Insulators

NAME AND MODEL NUMBER—Goodrich Vibro-Insulators types 44, 50 and 60.
PURPOSE—For isolating vibration.
FEATURES—Type 44 is for use with gas burners and is furnished either with rubber in shear or in compression. In shear the maximum loading is 10 lb while in compression the maximum loading is 50 lb. Type 50 is engineered to isolate internal combustion engines against torsional vibration and is said to take care of minimum disturbing frequency from 1200 per minute and up. Type 60 is used for isolating the vibration and noise of exhaust and intake fans. It is a compression mounting, used where the disturbing frequency is 1000 per minute with a maximum recommended load of 240 lb.
MADE BY—*The B. F. Goodrich Co., Akron, Ohio.*

Servel Year Round Conditioner

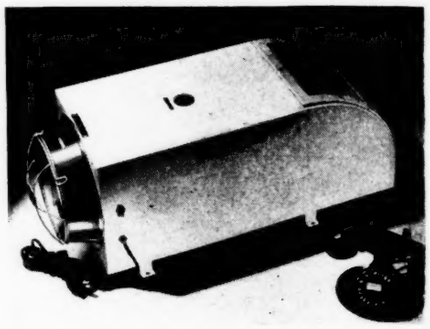
NAME AND MODEL NUMBER—Servel all-year gas air conditioner, models CHA-3-6, CHA-3-12, CHA-5-12 and CHA-5-18.
PURPOSE — To provide winter heating, summer cooling, year-round circulation, air cleaning, winter humidifying and summer dehumidifying.
FEATURES — Air conditioner is absorption-type unit, using gas heat to provide steam which operates cooling unit in summer and supplies heating coils in winter. Same burner and control system are used for both operations. Air conditioner usually installed in basement, and is operated by Selectrol control from living quarters of house, which regulates heating, cooling and ventilating by separate switches. Water is used as refrigerant in cooling system. Since pressures within system are below atmosphere, pressure necessary to operate system can be maintained by columns of solution and water. For this reason, cooling unit has no moving parts.
SIZES AND CAPACITIES—Four sizes and capacities; CHA-3-6, three tons cooling, 60,000 btu input for heating; CHA-3-12, three tons cooling, 120,000 btu input for heating; CHA-5-12, five tons cooling, 120,000 btu input for heating; CHA-5-18, five tons cooling, 180,000 btu input for heating.
MADE BY—*Servel Inc., Evansville, Inc.*



Servel gas-fired year-round air conditioner.

Tracing Cloth

NAME—Masterrepro water-proof tracing cloth.
PURPOSE—Special type for reproducing pencil or ink tracings.
MADE BY—*The Frederick Post Company, Hamlin & Avondale Ave., Chicago, Ill.*



Portable odor adsorber.

Dorex Type A Adsorber

NAME—Type A Dorex odor adsorber.
PURPOSE—Designed for odor adsorption in homes, doctors' offices, small shops, reception and dressing rooms.
FEATURES—Device in an attractive, streamlined enameled metal case with chromium trim, and can be used either as a portable or stationary model. It is 24 inches long, 10 inches high and 10 inches wide, with a 40-watt motor, includes circulating fan, dust filter, and four carbon filled canisters. With this equipment average sized store, office, or kitchen can be made odor-free in a few minutes. Upkeep is nominal, inasmuch as the carbon when saturated can be reactivated and reused. In operation the foul air in a room or enclosure is drawn into the adsorber where it passes through the bed of activated carbon. The countless canals and capillaries in the carbon remove and hold securely the entrained odors and gases, leaving only pure air to circulate in the room.
SIZES AND CAPACITIES—24 x 10 x 10 inches, 40-watt motor, 100 cfm.
MADE BY—*Dorex Division, W. B. Connor Engineering Corp., New York, N. Y.*

Oilbuster

NAME—Oilbuster.
PURPOSE—A liquid boiler compound for removing oil and rust and preventing foaming and priming.
FEATURES — Liquid is a chemical which coagulates oil and reduces solids to a state of flux. Product is said not to precipitate or settle and will clean the boiler within 2½ to 4 hours. To use, liquid is poured into the boiler and boiler is fired from one to two hours with water at the top of the gauge, then drained to bottom of gauge. Boiler is refilled to top of gauge and when again boiling, drained to bottom of gauge. This is repeated a few times until water becomes clear and holds a steady level.
MADE BY—*Cannon Chemical Company, Everett, Mass.*

On defense work...

give 'em a job that will last

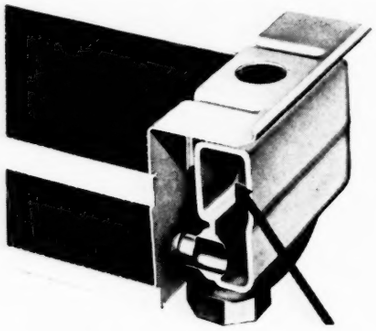
WITH

BETH-CU-LOY GALVANIZED STEEL SHEETS

Sheet metal work on defense jobs—whether housing or industrial expansion—deserves the protection of rust-resisting Beth-Cu-Loy Galvanized Steel Sheets. Doubly guarded against corrosion by a tight coating of zinc plus 0.20 to 0.30 per cent copper added to the steel itself, Beth-Cu-Loy Sheets are good for longer life. Yet the added cost is only a few cents more per sheet. When you figure on defense work, include Beth-Cu-Loy in your plans. You'll find these extra-durable sheets easy to work as well as economical.

BETHLEHEM STEEL

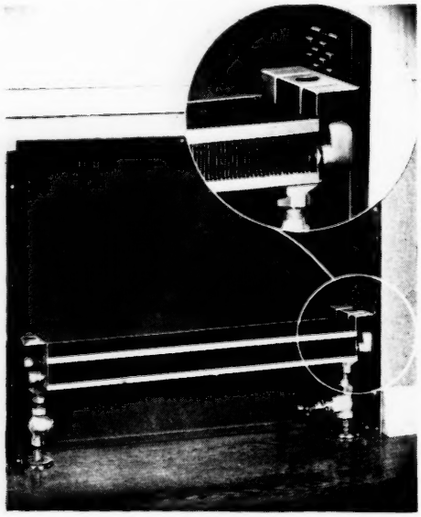
BETHLEHEM STEEL COMPANY



Arrow indicates built-in air chamber on Modine hot water convector heating unit.

Modine Convectors

NAME—Modine convectors.
PURPOSE—A new line of four different types including Hiflo for one-pipe and gravity hot water systems, Turboflo for two-pipe forced hot water system, Standard for vapor and vacuum steam, and Quiet-Seal for one-pipe steam system.
FEATURES — Hot water convectors have a built-in air chamber (illustrated), eliminating need for purchasing and installing accessory air storage equipment. Enclosures have built-in heating units, permitting manual pitching of units at several different elevations and degrees of pitch (also illustrated). Units are forwarded to jobs in their enclosures, simplifying installation. Recessed enclosures are designed to permit setting-in on the job of fiber-board insulation between sheathing and enclosure back.
SIZES AND CAPACITIES—Each type available in a full line of sizes and capacities.
LITERATURE AVAILABLE—Thirty-two-page catalog 241-A which includes hot water and steam engineering data as well as roughing-in dimensions and instructions.
MADE BY — *Modine Manufacturing Company, Racine, Wisc.*



Modine manually adjustable convector heating unit support.

Pangborn Dust Collectors

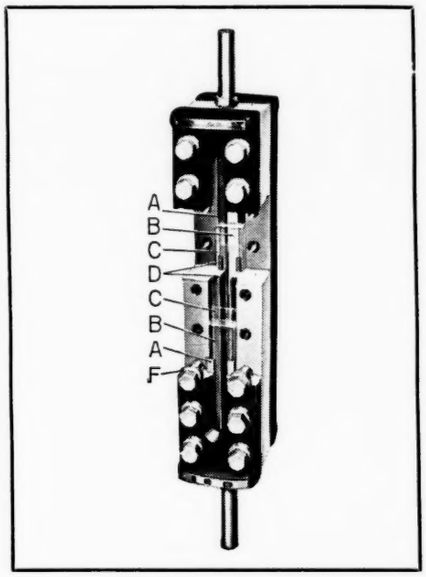
NAME—Type CD-1 unit dust collector.
PURPOSE — For attachment to and collecting dust from individual machines such as grinders, planers, blast cleaning units and tumbling mills.
FEATURES—The collector consists of a series of filter fabric bags mounted on frames in dust tight casings with hoppers at the bottom. Screen frames are closed at bottom and both sides, leaving the tops open for air passage. Dust-laden air enters casing below screens where, striking a baffle plate, velocity reduction occurs with coarse dust particles dropping to hoppers. Finer dust particles are retained on the cloth screens. Casings are of 16 gauge sheet steel. Unusual feature is portable unit No. 14, type CD-5, mounted on wheels for transporting from place to place. Removable dust drawer acts as hopper.
SIZES AND CAPACITIES — In addition to portable type, collectors are made in four sizes with cloth area ranging from 180 to 720 sq ft.
LITERATURE AVAILABLE—Bulletin 907.
MADE BY — *Pangborn Corporation, Hagerstown, Md.*

Reco Heat Circulator

NAME—Reco heat circulator.
PURPOSE—Circulator for near-ceiling application to reduce air stratification.
FEATURES—Fan consists of a vertical suspended motor on tubular frame fastened to ceiling fixture and supporting, above the motor, a propeller type fan which blows air to ceiling so as to cause it to react and drop to the floor and thus reduce the stratification of relatively high temperature air in the upper portion of the room.
MADE BY—*Reynolds Electric Co., 2650 W. Congress St., Chicago, Ill.*

Electromode Room Heater

NAME—Electromode Bilt-In-Wall electric heater.
PURPOSE—For auxiliary heating in bathrooms, dens, nurseries or for spring and fall use in any room.
FEATURES—Contains cast-in electric safety element so that there are no exposed hot wires or glowing elements of any kind. Can be turned on or off by a snap switch. Has quiet motor-driven fan.
SIZES AND CAPACITIES—1500 watts; front plate, 11½ in. wide and 12¾ in. high. Cost, $29.50.
LITERATURE AVAILABLE — Single sheet description, IRXM-7-41.
MADE BY—*Electric Air Heater Co., Division of American Foundry Equipment Company, 617 S. Byrkit St., Mishawaka, Ind.*



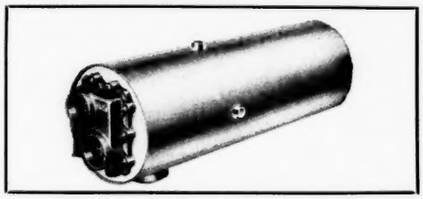
Insert for water level gages.

Water Gage Inserts

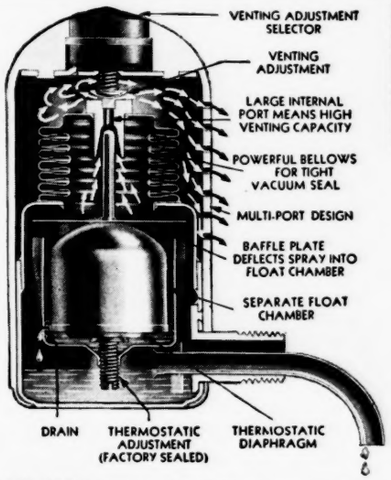
NAME—Improved pressure-sealed flat-glass insert for boiler water level gauges.
PURPOSE—For high pressure boilers up to 1500 lb.
FEATURES—Has cushion gaskets on outer faces of glasses. Thin sheets of India ruby mica protect inner surfaces of the flat glasses from etching action of steam and water. Spring cones on each cap screw limit the amount of pressure on glasses and gaskets and prevent harmful compression on glasses when covers are tightened down.
MADE BY—*Yarnall-Waring Company, Chestnut Hill, Philadelphia, Pa.*

Taco Gravity Water Heater

NAME—HG Tacos.
PURPOSE — For heating service hot water.
FEATURES—HG Tacos are horizontal gravity water heaters for use with storage tanks from 700 to 3000 gal capacity. They are equipped with heavy gauge steel shells and heavy bronze heads. Manufacturer states that these Tacos have an unusual adaptability for meeting tight spots as far as space is concerned since the shell tappings can be located to meet the requirements of the job.
CAPACITIES—For use with storage tanks 700 to 3000 gal.
MADE BY — *Taco Heaters, Inc., 342 Madison Ave., New York, N. Y.*



Taco service hot water heater.



AIRLINER—the aristocrat of air and vacuum valves. Revolutionary features are the separate float chamber and ingenious baffle plate which eliminate spitting or spurting under every *possible* condition—something that has never before been fully accomplished.

75 years of learning how NOT to make mistakes

IF you look back over the history of Marsh Equipment you will find that no manufacturer in this field has contributed more new ideas than has Jas. P. Marsh. But—still more significant than that, you will find that each contributed something sound, practical, and useful to the heating industry—some way of doing the job better than it was ever done before.

In the Marsh Equipment illustrated here history is simply repeating itself. The new Marsh Radiator Air Valves, for instance, have features that were never before found in equipment of this type. And the record of Marsh Equipment is your guarantee that these features are as *sound* as they are *new*.

When you're up against a tough problem, try the Marsh solution—install the equipment that has been developed by an organization which has spent 75 crowded years learning how NOT to make mistakes.

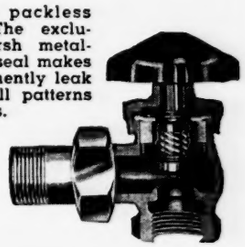
JAS. P. MARSH CORP., 2089 Southport Ave., Chicago, Ill.

MARSH —of course

Marsh House Heating Boiler Gauges cover all requirements of steam and hot water boilers.

AIROVENT—has the basic betterments of the Airliner at an attractive price. Adjustable venting with and without vacuum check.

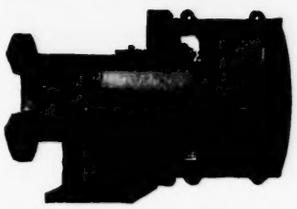
A *real* packless valve. The exclusive Marsh metal-to-metal seal makes it permanently leak proof. All patterns and sizes.



Marsh traps include radiator traps, float and thermostatic traps, and inverted bucket traps.

ADSCO INTERNALLY-EXTERNALLY GUIDED JOINT

MOST COMPLETELY GUIDED, DEPENDABLE SLIP TYPE JOINT



Important Features

- Internal Guide on Slip
- External Guide in Hood
- No metal to metal contact between slip and body
- Semi-steel or Steel Body
- Bronze or Chromium plated steel slip
- Properly proportioned stuffing box
- Available in various sizes for high pressures and temperatures
- Lubrication Fittings

APPROVED by the ARMY and NAVY for NATIONAL DEFENSE PROJECTS

The ADSCO Internally-Externally Guided Expansion Joint meets the specifications of the Army Quartermaster Corps and the Navy Department Specification No. 66Pla. It has been approved for many years for installation on Army and Navy projects where the expansion and contraction of steam or hot water lines must be controlled with dependable equipment.

Hundreds of this type of expansion joint have been and are being installed in steam distribution systems serving army and navy hospital buildings; navy yard shop buildings; ordnance plants; airplane factories and other industrial plants working on national defense orders.

Write for Bulletin No. 35-20V

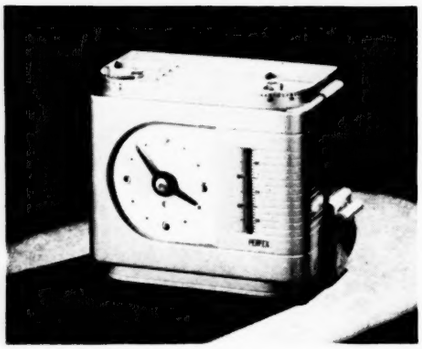
Partial List of Users

U. S. Naval Air Station Jacksonville, Fla.
U. S. Naval Air Bases Alaska
U. S. Naval Base Pearl Harbor, T. H.
U. S. Marine Hospital Carville, La.
U. S. Army Barracks Carlisle, Pa.
U. S. Army, McChord Field Fort Lewis, Wash.
U. S. Army, Chanute Field Rantoul, Ill.
U. S. Army Ordnance School Aberdeen, Md.
U. S. Army Base Anchorage, Alaska
Norfolk Naval Hospital Portsmouth, Va.
Naval Air Station Lakehurst, N. J.
Fort McClellan Anniston, Ala.
Army and Navy Hospital Hot Springs, Ark.
U. S. Army Barracks Plattsburg, N. Y.

AMERICAN DISTRICT STEAM COMPANY

NORTH TONAWANDA, N.Y.
IN BUSINESS OVER SIXTY YEARS

New Equipment



Twin contact magic dial thermostat.

Perfex Thermostat

NAME—Twin Contact Magic Dial thermostat.

PURPOSE—Clock thermostat for automatic heating.

FEATURES—Day-night controlling circuits are switched at desired times by a switching mechanism operated by the synchronous electric clock, which has conventional hand and dial design for easy reading. Day temperature is set by adjusting lever to desired room temperature position; night temperature is set by adjusting the night set-back lever to the number of degrees difference required between day and night control temperatures. If night set-back lever is set at ten, the night control will be ten degrees lower than day control. If lever is set at zero, day temperature regulation continues throughout the twenty-four-hour period. Day and night change-over times are established by day and night dials, each graduated in hours, and indicator on the clock face shows whether operation is on day or on night control. Instrument has attractive functional styling.

MADE BY—*Perfex Corporation, 500 West Oklahoma Ave., Milwaukee, Wis.*

Wolfe Angle Meter

NAME—Wolfe circle meter and Wolfe angle meter.

PURPOSE—The circle meter is a four-color chart which folds to 12 in. x 4½ in., giving readings of diameters and circumferences of any circle up to 72 in. in diameter in steps of ⅛ in. or smaller. Angle meter is a chart which folds to 12 x 4½ in. and used for laying out on pipe or flat material any angle bend from 0° to 90°. Intended for engineers, draftsmen, welders and sheet metal workers.

FEATURES—The angle meter makes it possible to lay out bends on pipe or ducts without the use of templets. Complete instructions are included on the chart. Circle meter can be used in combination with angle meter to save time in figuring material. Price of each, $2 when sold separately.

MADE BY—*Interstate Sales Company, 1123 Broadway, New York.*

Gas Unit Heater

NAME—Utility gas-fired unit heaters.

FEATURES—Heating element has corrugated sections with no interior baffles. Streamlined design and installation close to ceiling are gained by use of built-in draft diverter and by compact motor and fan arrangement. Cabinet is die-formed with directional grilles. Controls include temperature limit switch and thermocouple type safety pilot. Manual control furnished unless automatic control is specified. Separate burners for each section of the heating element prevent excessive temperature.

MADE BY—*Utility Fan Corporation, 4851 S. Alameda, Los Angeles, Cal.*

All-Weather Springs

NAME—All-Weather self-compensating springs.

PURPOSE—Self-compensating springs which are not affected by temperature.

FEATURES—Manufacturer states that while the ordinary steel or alloy spring becomes approximately 2% more resilient for every 100F increase in temperature it is claimed that these new self-compensating springs can be held constant within these limits to .02%. These springs utilize the property of 36% nickel steel which becomes stiffer as its temperature increases. Such springs are combined with undercorrecting springs, that is, springs having an opposite tendency or with other elastic elements such as bellows, diaphragms, etc., to produce instruments the accuracy of which is virtually unaffected by temperature changes. Manufacturer states that these springs are now being used in spring scales, aeronautical instruments and other spring actuated instruments which must be used in localities where they are exposed to a wide variation in temperature.

MADE BY—*All-Weather Springs, 72 Washington Street, New York, N. Y.*

Sampsel Pressure Switch

NAME—Sampsel automatic pressure switch.

PURPOSE—Automatic pressure control for use with low pressure water systems.

FEATURES—Designed to control the pressure in water systems where an electric pump is used to maintain a given pressure. With this control in use, settings may be obtained so as to start or stop the electric motor at desired pressure within limits of control. Switch is operated by a rubber diaphragm moving a pivot disc and actuating a free-floating toggle link mechanism which opens and closes both sides of the line. Can be supplied either with or without short pipe nipple for tapped hole mounting, will fit a ¼ in. standard pipe thread, and can be mounted in a turning radius of 1¾ in.

SIZES AND CAPACITIES—The range pressures can be adjusted from 10 to 25 lb closing pressure and from 30 to 45 lb opening pressure.

MADE BY—*Sampsel Time Control, Inc., Spring Valley, Ill.*

Castable Refractory

NAME—Plicast L-W-I.

PURPOSE—A light weight insulating castable refractory for service temperatures as high as 2200F.

FEATURES—Refractory is said to combine all of the usual advantages of castable refractory materials with additional features of high insulating value and light weight. Thermal conductivity reported as 30% that of ordinary fire brick, with 60% lower heat storage capacity and with 60% less weight than fire brick. Manufacturer recommends its use where weight is an important factor and for such installations as oil and gas burner jobs where refractory's low heat storage is an advantage. Available in dry form in moisture-proof bags. Powder is mixed with a minimum of 6 gal of water per bag, then poured into forms or moulds of desired shape. Requires setting time of 12 to 24 hours.

LITERATURE AVAILABLE—4 page bulletin.

MADE BY—*Plibrico Jointless Firebrick Co., 1800 Kingsbury Street, Chicago, Ill.*

Westco Pumps

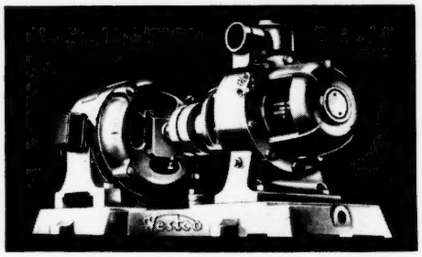
NAME—Westco turbine type pumps.

PURPOSE—For brine circulation, steam service, air conditioning, spray equipment, water supply systems, and similar applications.

FEATURES—A series of single and two-stage pumps incorporating a patented renewable liner which forms the liquid channel and which can be easily and quickly removed. Separate liner design guards against premature obsolescence by permitting the pump capacity and range to be altered in the field without disturbing the suction or discharge lines.

SIZES AND CAPACITIES—Available in a wide range of sizes and capacities.

MADE BY—*Micro-Westco, Inc., Bettendorf, Iowa.*



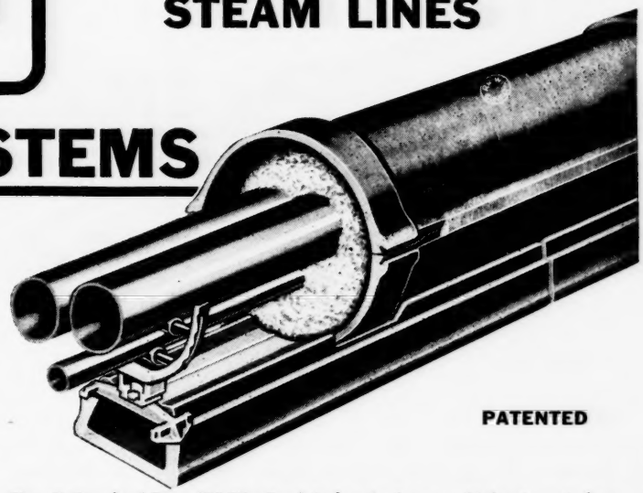
General purpose turbine type pump.

RIC-WIL

FOR UNDERGROUND STEAM LINES

TILE CONDUIT SYSTEMS

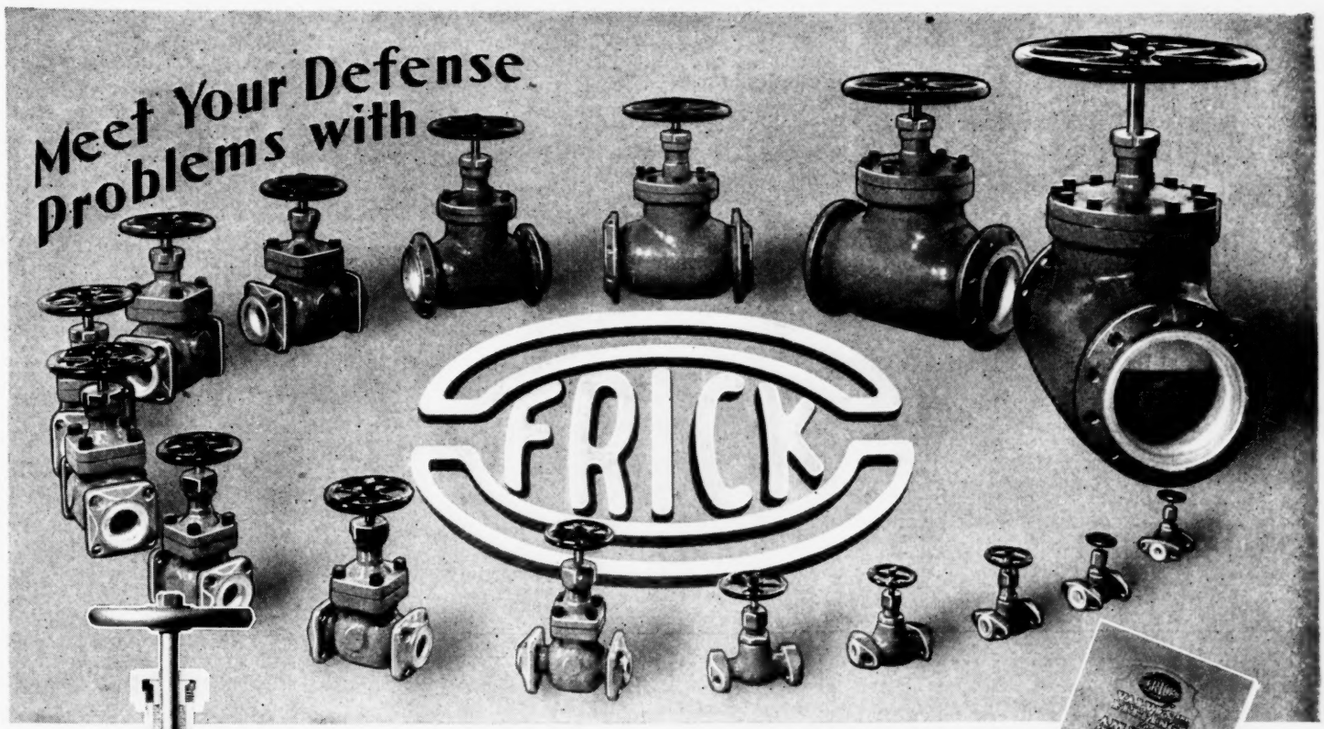
Since 1910 Ric-wiL has served, with outstanding leadership, the country's needs on underground steam protection. Ric-wiL pioneered in the tile conduit field. Today, when material supply, production facilities, and plant personnel are subject to severe pressure, it is a point of pride with us, that in Ric-wiL Tile Conduit, traditional standards of quality are being scrupulously maintained. • More than that, we are now better equipped than ever before for quick delivery in practically all sizes. For defense or other requirements, Ric-wiL stands ready to serve, promptly and dependably.

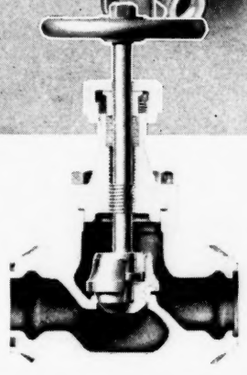


PATENTED

Ric-wiL Standard Type "F" Tile Conduit, for single or multiple pipes, is factory made and shipped complete, ready for fast installation with a minimum of field supervision. Ric-wiL design, materials, and engineering provide every essential advantage — proper under-drainage, strength, water-tightness, pipe support, alignment, thermal efficiency, low installation cost. • Standard insulation is Ric-wiL Waterproof Asbestos Dry-paC, of unequalled durability and efficiency. • Ric-wiL also makes heavy-duty SuperTile Conduit for use under road traffic, and cast-iron conduit for use under railroad tracks. Complete Catalog 41, describing all Ric-wiL Systems, sent on request.

THE RIC-WIL COMPANY • **CLEVELAND, OHIO**
AGENTS IN PRINCIPAL CITIES





Semi-steel Valves

They are preferred for a wide variety of uses. Frick valves hold gas or liquid pressures up to 300 lb. gage, whether handling ammonia, Freon-12, Methyl Chloride, air, CO_2, natural gas or other substances at normal or cold temperatures, not attacking steel. Only in Frick valves can you get the patented high-angle seat, alloy-faced button, oversized stem, easy repacking and other features, which have given them the preference for generations. Full range of sizes, $\frac{1}{4}$" to 14"; screwed valves up to 2"; stocked by Frick Distributors in principal cities everywhere. Ask for catalog K, showing both valves and fittings — sizes, dimensions, weights, prices — and many useful tables. Write.

Frick Co., Waynesboro, Pa.

ABSTRACTS

(Continued from page 56)

DISTRIBUTION COSTS. An international encyclopedia of distribution costs covering approximately 30 separate lines of business for years ranging over the past quarter of a century, has been published as a Harvard contribution to business. Included in the trades and industries section is a classification on plumbing and heating supplies. [*"Distribution Costs—An International Digest." 652 pages; 8½ x 11 in.; 393 tables. Published by Bureau of Business Research, Harvard Graduate School of Business Administration, Boston, Mass. Price, $10*].

SMOKE AND BACTERIA. In a British investigation on germicidal aerosols it was discovered that smoke interfered with bactericidal activity. Smoke from various sources including tobacco and cardboard, will exert some destructive influence. However, to be germicidal, smoke must be present in particulate form. The article includes tables showing the relative lethal effect of different smokes upon different bacteria. [*"Effect of Smoke on Bacteria in the Air," by C. C. Twort and A. H. Baker. Published in The Lancet, 7 Adam St., Adelphi, WC2, London, England, 19, 587-588, Nov. 9, 1940*].

DISTRICT HEATING. The complete collection of the papers, talks, and committee reports presented at the June meeting of the National District Heating Association has been published in the 1941 Proceedings of the National District Heating Association. Committee reports include those on operating statistics, sales developments, commercial relations, distribution, research, meters and accessories, and others. [*"1941—Proceedings of the National District Heating Association", 297 pages; cloth bound; 5¾ x 9 in. Published by the National District Heating Association, 827 North Euclid Avenue, Pittsburgh, Pa. Price, $5.*]

CONDUCTIVITY. A four-page folder on the computed thermal conductivity of common woods giving the conductivity in the form of two equations, one where the wood has a moisture content of under, and the other where the wood has a moisture content of over, 40%. Also includes a table on the average specific gravity of various woods and a graph showing the conductivity based on the moisture content and specific gravity. [*"Computed Thermal Conductivity of Common Woods," published by Forest Products Laboratory, U. S. Forest Service, Madison, Wis. 4 pages; 5¾ x 8 in.*]

STEAM. A 163-page mimeographed book on low pressure steam engineering and containing a great deal of practical information on the operation and maintenance of steam and hot water heating plants, including discussions on oil and gas burning, together with chapters on hot water for domestic use. Much of the information in this book is of the type usually obtained only by experience and seldom published in textbooks. [*"Low Pressure Steam Engineering Handbook," by Frederick N. Broderick. Paper cover; lithographed; 5¾ x 9 in.; 163 pages. Published by the author at 1762 Filbert St., San Francisco. Price, $2.*]

WITH THE MANUFACTURERS

The Trane Company, LaCrosse, Wisc., has received word that the British Trane Company, Ltd., of London, has been bombed. Temporary premises were taken and a new location for the company found in the Midlands. The new plant is already in production and it is expected that three months after the misfortune the plant will be producing at its normal rate.

Joseph T. Ryerson & Son, Inc., Chicago, has installed a modern, 24 ft annealing furnace for annealing their stock steel products after they have been flame cut. Usually it is not necessary to anneal after flame cutting. However, with some types of steel, occasionally in the case of plates, and in some situations this is desirable. The furnace can be divided into three sections. Each of the three furnaces may be used as a separate unit, making possible prompt annealing service. The furnace is crane-served and so situated that steel to be annealed can be quickly transported to the furnace from any part of the Ryerson plant.

The National Radiator Co., Johnstown, Pa., announces that three of its branch offices moved to larger quarters: a warehouse, display room and office were opened by branch manager *Paul Bracken* at 34 Roland Street, Charlestown (Boston), Mass.; a similar arrangement is now serving northern New Jersey from 30 Lister Avenue, Newark, where *J. T. Ellis* is branch manager; the Richmond, Va., office has moved to a suite of rooms on the fifth floor of the Richmond Trust Company Building. *William E. Austin* is branch manager.

Servel, Incorporated, Evansville, Ind., has been elected to membership in the Air Conditioning and Refrigerating Machinery Association, Inc.

PERSONALS & PERSONNEL

Fedders Manufacturing Company, Inc., Buffalo, N. Y., announces the appointment of *Clarence E. Scott* as sales manager of its Air Conditioning Division, in charge of sales of the company's unit heaters, heating and cooling coils, air conditioning units and associated products. Mr. Scott at one time was research engineer for York Heating and Ventilating Corporation, later manager of the unit heater department of Carrier Corporation, and recently manager of radiation and unit heater department of Warren Webster & Co. He succeeds *Edmund R. Walker* who has been promoted to assistant general manager of Fedders Mfg. Company, Inc.

Clarence E. Scott

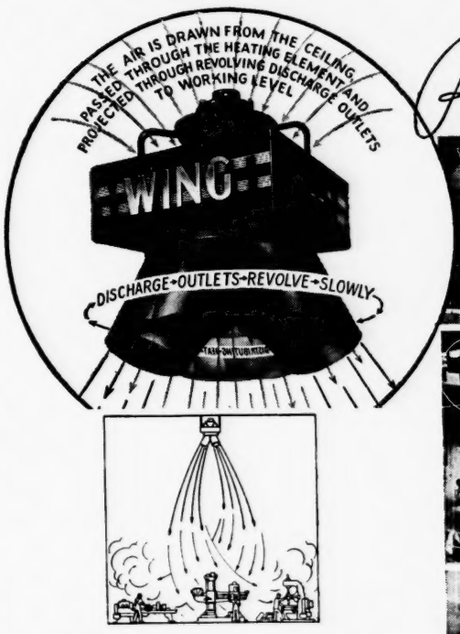
York Ice Machinery Corporation, York, Pa., has appointed *Edgar F. Heckert* as special assistant to the general works manager. Mr. Heckert was formerly manager of the service department.

General Electric Company, air conditioning and commercial refrigeration department, Bloomfield, N. J., has appointed *Ernest Macaulay* advertising manager, succeeding *Glenn Gundell*, transferred to Bridgeport.

A New, Logical Method of Heating Industrial Buildings that is Setting New Standards of Comfort in Working Conditions

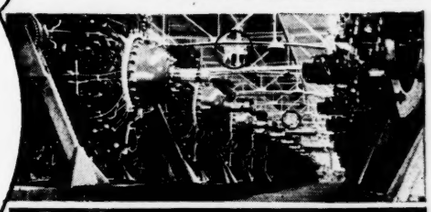
The gentle air motion created by the constantly changing direction of a WING Revolving Unit Heater brings a sensation of fresh, live, invigorating warmth to workmen, increasing their sense of comfort and promoting health and efficiency.

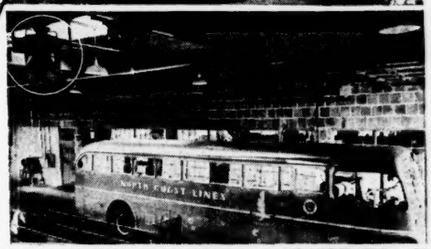
A prominent architect says: "WING Revolving Unit Heaters would be worth installing if they cost TWICE AS MUCH!" But they don't! In most cases they cost less. A new, complete catalog, Bulletin HR-1 is available.

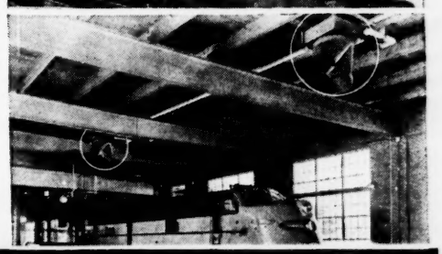

THE AIR IS DRAWN FROM THE CEILING, PASSED THROUGH THE HEATING ELEMENT AND PROJECTED THROUGH REVOLVING DISCHARGE OUTLETS TO WORKING LEVEL
WING
DISCHARGE OUTLETS REVOLVE SLOWLY

The area covered by a WING Revolving Unit Heater is slowly swept by the heated air discharged by the outlets which move through 360° successively in every direction.

Revolving **HEAT DISTRIBUTION**







L. J. WING MFG. CO., 158 W. 14th St., **New York, N. Y.**

WING Revolving UNIT HEATERS

WE ARE BUSY

We are doing our part in the National Defense Program

BUT—WE ARE NOT TOO BUSY to take care of our regular clientele.

Place Orders as Early as Possible

Shell and Tube Condensers—Evaporative Condensers—Shell and Tube Water Coolers—Storage Water Coolers—Pipe Coils—Cooling Units—Heat Exchangers

Jackson **ACME INDUSTRIES** Michigan

The All Purpose

AIR VELOCITY METER

Alnor VELOMETER

INSTANTANEOUS DIRECT READING

ASK FOR BULLETIN 244ED

Illinois Testing Laboratories Inc.

143 W. HUBBARD ST., CHICAGO, ILL.

Ask for facts concerning

THERM-O-TILE

Reg. U.S. Pat. Off.

It is the Simplest, Strongest, Most Efficient, and Only Truly Complete Conduit for Underground Pipe Lines

Sold and installed by Johns-Manville Construction Units in all Principal Cities.

See our page in Sweet's or The Heating Guide.

Monolithic concrete base. No broken stone fill. No bell joints. Build to correct grade and that grade will never change. Condensate pockets cannot form. Strong arched construction. Internal channel drain. Etc. For the numerous other reasons why Therm-O-Tile is the superior conduit system, ask for Builetin 381.

H. W. PORTER & CO., Inc.

823-V Frelinghuysen Ave., Newark, New Jersey

Without obligating us in any way, ☐ Please send Bulletin 381. ☐ Send representative. ☐ Enclosed is a sketch, with principal data of a prospective job, on which we shall be glad to have your ☐ comments, ☐ quotations.

Name .....

Firm .....

Street .....

City ..... State .....

GET HEAT!

•Quickly
•Cheaply

May We Send You This Booklet?

Fortunately, the direct fired method of heating was developed, perfected and proved in actual use during those years when strict economy was a prime necessity. Today the speed with which a Dravo Heating System can be installed, matches the tempo of defense construction, and still gives you economy of installation and operation. By heating air direct, without the medium of steam, you avoid the delay and expense involved in building boiler plants and installing piping. Dravo Direct Fired Heaters are invaluable for temporary heat... Study of the proven data in Dravo Bulletin 502 will save you weeks of heating installation time right now. It presents proof of economy, speed and over-all efficiency. Write or wire,

SEE OUR CATALOG IN SWEET'S

DRAVO CORPORATION

MACHINERY DIVISION—HEATER DEPARTMENT

300 Penn Ave., Pittsburgh, Pa.
Broad St., Station Bldg., Philadelphia, Pa.
4800 Prospect Ave., Cleveland, Ohio

NEW TRADE LITERATURE

Boilers. Four single sheet circulars, 104d, 114.80, 91.15d, and 91.22e. Standard size, six-hole punched for standard binders. Devoted to the company's 400 series riveted up-draft high and low pressure boilers; the 5000 series of welded and riveted up-draft low pressure boilers, and the G series of all welded smokeless low pressure boilers. Includes specifications, tabulations, illustrations and diagrams. KEWANEE BOILER CORPORATION, KEWANEE, ILL.

Expansion Joints. A standard size, 16-page Bulletin EJ-1908, describing the company's Gun-Pakt expansion joints. Numerous illustrations show the range of types in which this joint is available while tables give dimensional and capacity data. A table on pipe expansion and a chart for steam pipe sizing are included. YARNALL-WARING COMPANY, CHESTNUT HILL, PHILADELPHIA, PA.

Unit Heaters. Quality construction of the company's unit heaters is featured in a 36-page catalog No. 141. Around the catalog is a bright yellow band headed "Check up for the Speed Up," leading the reader into a Check-Chart in which the company's product is compared with three other unit heaters on the basis of eleven essential features. Space is provided for comparison with any other make of unit heater on the market. An offer is made of a free heat survey. Features of the construction are illustrated and described, followed by illustrations and data on the four lines of unit heater models. Engineering data, including tables, illustrations pointing out the proper location of units in various types of buildings, piping diagrams, etc., fill the remaining pages. ILG ELECTRIC VENTILATING CO., CHICAGO, ILL.

Water Treatment. A four-page folder in color entitled "Your Boilers—How to Make and Keep Them Clean, Efficient, Economical," and devoted to the company's water treatment for boilers, stills and evaporators, written in question and answer form, and explains the conditions that require water treatment, difference between various kinds of cleansing agents and information on methods that have proven successful. AMERICAN K.A.T. CORPORATION, 221 EAST 42ND ST., NEW YORK.

Vibration Isolation. Stripped of highly technical descriptions of the problem of isolating vibration in machines, this 12-page catalog section on the company's Vibro-Insulators, explains these devices for combating the vibration and noise problem. Illustrated, both with actual installation pictures and engineer's drawings of each type of Vibro-Insulator, the catalog section gives pertinent information on each. Methods of selecting the proper mounting are given, together with methods of mounting, and discussions of uniformity of load distribution, rocking and horizontal motion and the care of the devices. Applications of the mountings on various types of equipment are listed, together with a table of characteristics. Nine pages are devoted to listing of the fundamental data for each type of mounting, together with an engineer's drawing of each. THE B. F. GOODRICH CO., AKRON, OHIO.

Convectors. A 4-page standard size folder, Bulletin No. C-451, devoted to the company's standard convectors, including dimensional and capacity data. McQUAY, INC., 1600 BROADWAY, N.E., MINNEAPOLIS, MINN.

Unit Heaters. A standard size, three-ring, loose-leaf-punched, 16-page catalog No. 2541, printed in color and describing and illustrating the company's line of Vertiflow unit heaters. Includes information on these units with both the company's Streamaire diffusers and with Anemostats, as well as the usual capacity and dimensional data, typical wiring diagrams and piping details. YOUNG RADIATOR COMPANY, RACINE, WISC.

Unit Heaters. Two 8-page standard size bulletins in color, No. 746 devoted to the company's down flow unit heaters, and No. 751 devoted to the radial type unit heaters. No. 751 lists the advantages of the radial heaters, shows construction details, and by means of drawings shows how the heaters should be arranged for typical installations. Steam and hot water capacity data are given, including a curve for determining the capacities of the units at various rates of water flow. Six sketches of wiring diagrams and four of piping details are also presented. No. 746 shows the standard down-flow unit and, in addition, the same unit with Anemostats and McQuay double cone diffusers. Mounting data with these different types of diffusers, capacity and dimensional data are included, as well as wiring and piping diagrams. MCQUAY, INC., 1600 BROADWAY, N.E., MINNEAPOLIS, MINN.

Evaporative Condensers. Bulletin No. 234-C, standard size, four pages, illustrating and describing the company's line of evaporative condensers for ammonia and Freon-12 refrigerating systems. FRICK COMPANY, INC., WAYNESBORO, PA.

Propeller Fans. An unusually elaborate and beautifully prepared catalog and data book on propeller fans. Booklet, entitled Propellair, is a standard size, 72-page catalog printed in color and includes full information on the company's complete line of propeller fans as well as a great deal of miscellaneous general engineering data associated with the application of these fans. PROPELLAIR, INC., SPRINGFIELD, OHIO.

Blow Off Valves. Standard size Bulletin B-421, 24 pages, in color, devoted to the company's blow off valves for low and medium pressure boilers. Shows types, arrangements, physical and chemical properties of materials and illustrations of typical installations. YARNALL-WARING COMPANY, CHESTNUT HILL, PHILADELPHIA, PA.

Draft. Publication No. 41-472, standard size, 20-page booklet in color, devoted to the subject of draft, how it is measured, what draft gages are for, where they should be connected and how they should be installed. One of a series on boiler room instrumentation and control. THE HAYS CORPORATION, MICHIGAN CITY, IND.

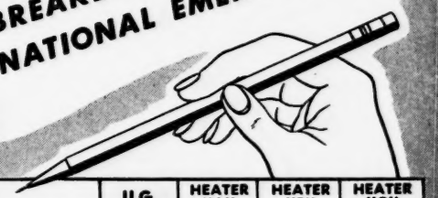
Unit Heaters. A booklet entitled Diffused Warmth and giving complete but concise information on how to size, select and install unit heaters. Includes information on horizontal throw type and vertical downward diffusion type unit heaters manufactured by the company. THE NATIONAL RADIATOR COMPANY, 221 CENTRAL AVE., JOHNSTOWN, PA.

Boilers. Single-page standard size, loose-leaf circular 93.80, devoted to the company's residence type steel boilers. KEWANEE BOILER CORPORATION, KEWANEE, ILL.

Motors. An eight-page bulletin No. B6052-B, describing the complete line of the company's Lo-Maintenance motors in ratings from ¾ to 75 hp open, enclosed and splash-proof types, a-c and d-c. ALLIS-CHALMERS MFG. CO., MILWAUKEE, WISC.

CHECK-UP for the SPEED-UP

DON'T RISK BREAKDOWNS DURING NATIONAL EMERGENCY!



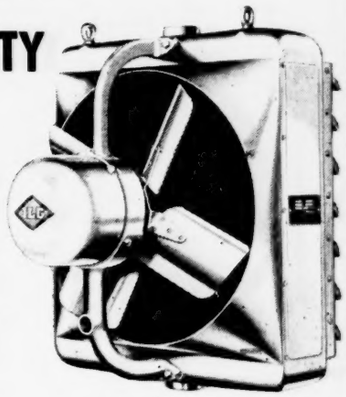
★ ESSENTIAL FEATURES	ILG	HEATER "A"	HEATER "B"	HEATER "C"
ENCLOSED SELF-COOLED MOTOR (Counteracts coil heat—never "slow roasts").	YES	NO	NO	NO
EYE BOLTS FOR CEILING SUSPENSION (Takes weight of unit off supply lines)	YES	YES	NO	YES
FOUR TYPES OF UNITS (To meet all heating requirements)	YES	NO	NO	NO
ALL-COPPER HEATING COIL (Best known common conductor of heat)	YES	NO	YES	YES
ALL INCLUSIVE "ONE-NAME-PLATE" GUARANTEE (Including motor and speed controller)	YES	NO	NO	NO
INDIVIDUALLY ADJUSTABLE LOUVERS (Less air turbulence—increase heating range)	YES	YES	YES	YES
DYNAMICALLY-BALANCED FAN WHEEL (Quiet, free-running, vibrationless)	YES	NO	YES	NO
TWO-PIECE HEADER (Same as used in high pressure boilers)	YES	NO	NO	NO
BACKED BY 25 YEARS' EXPERIENCE (In building propeller-fan-type unit heaters)	YES	NO	NO	NO
AVAILABLE IN RANGE OF COLORS (To harmonize with decorative plan)	YES	NO	NO	NO
COIL TESTED TO 500 LBS. HYDROSTATIC PRESSURE PER SQUARE INCH (No drips . . . no leaks)	YES	NO	YES	NO

★ *Comparison is made here between ILG and three other top-flight unit heaters on the basis of* essential features. *Check these same points with any other unit heater made today!*

ILG "3-SHIFT" QUALITY

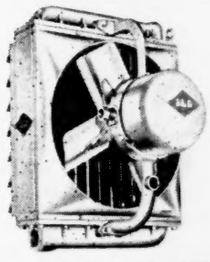
all along the line!

3 shifts a day? 24-hour-a-day continuous operation? 3 years of hard wearing life packed into one? Sure! And it's no emergency for ILG Unit Heaters! For these "toughie" units have been the choice of shrewd, far-sighted management for over 25 years—have demonstrated their ability to "take it" under all sorts of grueling grinds. See for yourself—phone or write for new Catalog No. 341—today!

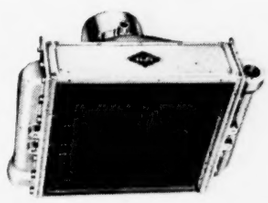


HORIZONTAL-TYPE

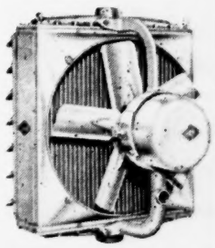
LOW-CEILING TYPE



VERTICAL-TYPE



TEXTILE-TYPE



ILG ELECTRIC VENTILATING CO. ★ 2858 N. CRAWFORD AVENUE ★ CHICAGO, ILL.

OFFICES IN 43 PRINCIPAL CITIES

ILG *Vital Zone*

UNIT HEATERS

★ HEAT THE *Vital Zone* WHERE PEOPLE WORK, SHOP AND PLAY

IN THE PRESENT EMERGENCY. . . .

Saving Fuel is a practical aid of far reaching value

Read the evidence: 33 buildings show average annual saving of 39.2%

DUNHAM DIFFERENTIAL VACUUM HEATING SYSTEM

*A Few Representative Buildings and Date of Installation—	Original Heating System	Dunham Heating System	Saving Effected
	Lbs. Steam	Lbs. Steam	
Office—1928	13,863,000	9,512,000	31.4%
Dormitory—1932	8,481,000	5,820,000	31.4%
Industrial—1933	80,117,000	44,409,000	44.5%
Dormitory—1933	13,770,000	8,780,000	36.4%
Educational—1933	8,615,000	5,748,000	33.3%
Educational—1933	$5014.00	$1424.00	71.6%
Industrial—1935	27,712,000	16,244,000	41.4%
Industrial—1935	27,134,000	15,575,000	42.6%
Hospital—1935	22,082,000	13,766,000	37.8%
Office—1936	4,484,000	3,076,000	31.5%
Printing—1936	1532 tons coal	1043 tons coal	31.9%
Office—1938	3,645,000	2,281,000	37.4%
Newspaper—1938	13,603,000 cu. ft. gas	8,458,000 cu. ft. gas	37.8%

*Names on request, and records for other installations.

WRITE FOR LIST OF NATION-WIDE Dunham Heated GOVERNMENT HOUSING PROJECTS

"Dunham Heating Service" is available through the telephone in more than 60 cities, or by correspondence to C. A. Dunham Co., 450 E. Ohio St., Chicago.

DUNHAM HEATING SERVICE

SUMMER DEGREE HOURS

The summer residential air conditioning load, mainly, has been shown to be proportional (in certain cases) to the number of degree-hours above 85F. That is, from the hourly dry bulb temperature 85 is subtracted, the remainder being the degree hours for that hour. These are totaled for the period in question.

SUMMER DEGREE HOURS (Above 85F) FOR JULY, 1941

City	Number of Degree-Hours July, 1941	Number of Degree-Hours Summer, 1941, to July 31
Baltimore	654	1517
Birmingham	520	1369
Bismarck	1002	1368
Boston	129	541
Buffalo	34	34
Chicago	407	745
Cincinnati	731	1235
Cleveland	620	1011
Columbus	763	1387
Des Moines	1022	1416
Detroit	515	883
Fort Wayne	676	1002
Houston	1126	1779
Indianapolis	1064	1724
Memphis	1361	2503
Milwaukee	342	544
Minneapolis	737	903
New Orleans	792	1537
New York	136	308
Oklahoma City	1819	2203
Philadelphia	299	813
Pittsburgh	306	492
Portland, Ore.	682	777
Richmond, Va.	674	1574
Rochester	453	740
St. Louis	1163	2092
San Diego	0	0
San Francisco	0	3
Savannah	825	1735
Syracuse	283	599
Toledo	479	859
Washington	512	1272

COMING EVENTS

DECEMBER 3-6. Annual meeting of the American Society of Refrigerating Engineers, St. Louis, Mo. Headquarters, Hotel Jefferson. Further information from ASRE, 37 West 39th St., New York.

JANUARY 26-30. Seventh International Heating and Ventilating Exposition to be held at Commercial Museum, Philadelphia, Pa. Further information obtainable from International Exposition Company, Grand Central Palace, New York.

JANUARY 26-30. Annual meeting of the American Society of Heating and Ventilating Engineers, Philadelphia, Pa. Headquarters, Bellevue Stratford Hotel. Further information available from ASHVE, 51 Madison Avenue, New York.

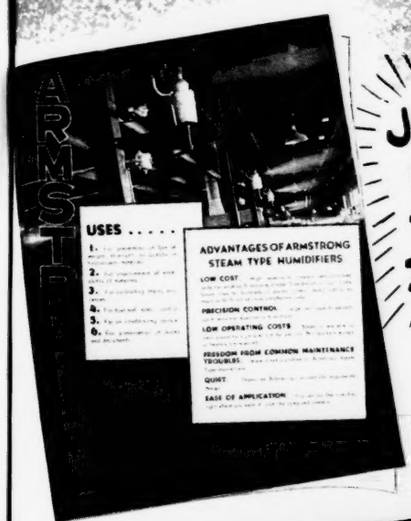
H&V'S PHOTOS

Pages 18, 19, 40 and 41—The Austin Co.
Page 25—Westinghouse Elec. & Mfg. Co., Pittsburgh.
Pages 26-28—Rich Economy Service, A. E. Kairies, and N. N. Nadeau, Minneapolis.
Page 31—OEM Defense photo.

HEATING AND VENTILATING

The Air Conditioning Monthly

...HEATING and VEN...
...will want a copy of this BULLETIN



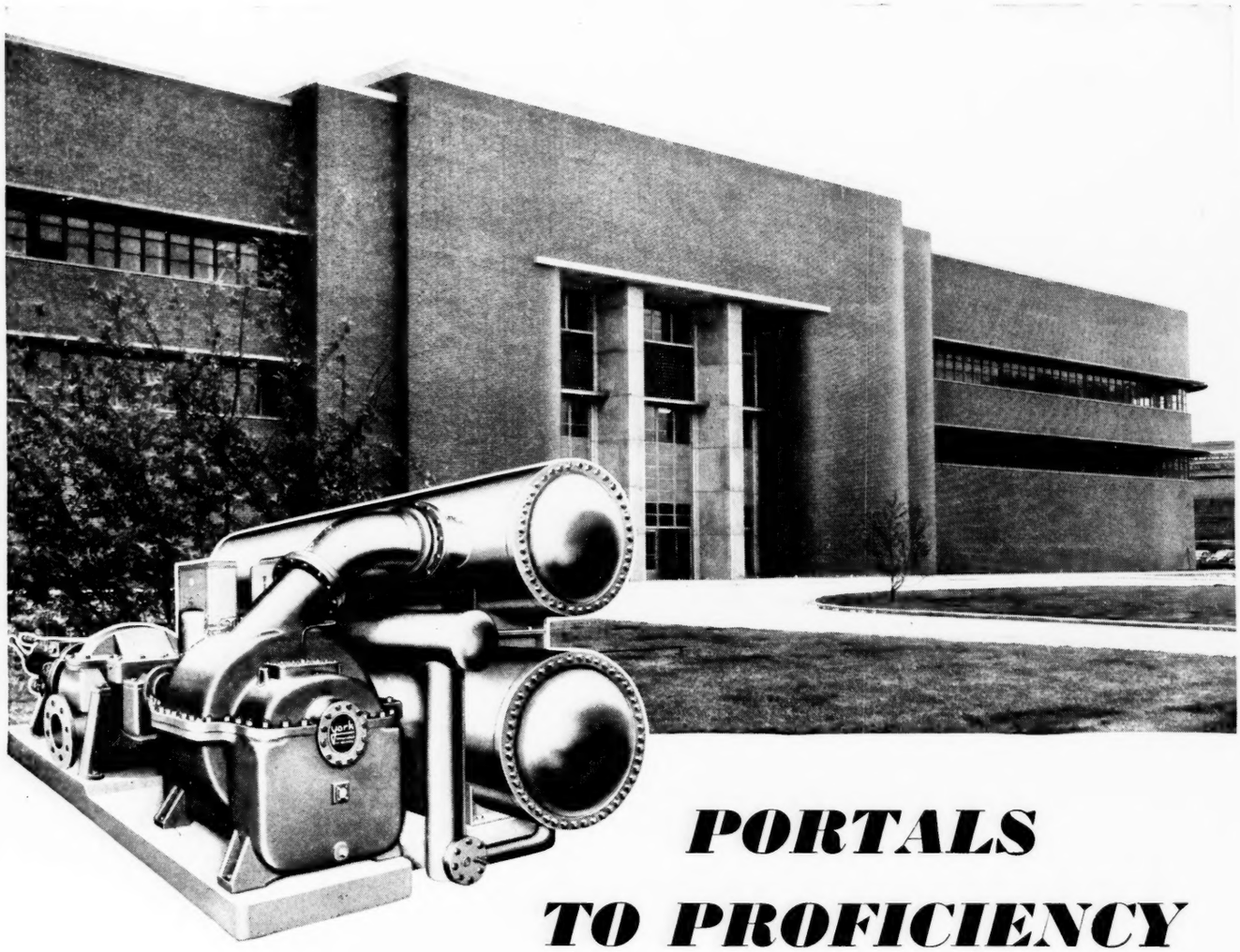
JUST OFF THE PRESS

THIS humidifier, equipped with humidistat, solenoid control valve, steam strainer, fan, condensate drainage trap, and capacity to humidify up to 40,000 cu. ft. of space, is offered at $100.00, list (Liberal discounts)

Read "FACTS YOU SHOULD KNOW ABOUT WINTER HUMIDIFICATION"

IF YOU have thought of humidification for industrial plants as being a comparatively expensive proposition involving installation of major equipment, prepare yourself for an entirely new conception of the problem. Armstrong has now made humidification practical for countless plants and buildings that could not begin to think of the cost of conventional installations. Complete facts have been published in the 8 page illustrated educational bulletin pictured above. We will mail you a copy immediately upon request. No obligation. ARMSTRONG MACHINE WORKS, 546 Maple St., Three Rivers, Mich.

Industrial



PORTALS TO PROFICIENCY

"Proficiency—advancement or progress in knowledge or skill."—Webster

Back of these doors, in 20 million cubic feet of air conditioned space, the Ford Motor Company will turn out engines for the Army's most powerful planes at the rate of one an hour.

Here, the largest air conditioning system operating in an American industrial plant, not only makes blackout construction possible, but speeds production.

Temperature control safeguards the uniformity of metal stocks, the accuracy of gages and machine tools . . . essential to maintain precision to one ten-thousandth of an inch in most of the parts of these 2000 h.p. Pratt & Whitney, 18 cylinder double-row engines.

Humidity control, together with elimination of dust and oil fumes eliminate the sabotage of corrosion in raw stock, parts in process or assembly.

And, as elsewhere, efficient air conditioning means less sweat, clearer eyes and steadier hands for every worker.

• • •

Whenever the clock strikes, think of one or more of these precision-built engines for defense . . . and think of York air conditioning too.

York Ice Machinery Corporation, York, Pennsylvania.

york refrigeration air conditioning

YORK REFRIGERATION AND AIR CONDITIONING

"Headquarters for Mechanical Cooling Since 1885"

A FEW OF THE MANY NATIONALLY-KNOWN USERS OF YORK EQUIPMENT—*American Cyanamid • American Optical • Bendix-Westinghouse Bethlehem Shipbuilding • Bethlehem Steel • Consolidated Aircraft • Curtiss-Wright • Douglas Aircraft • du Pont • Eastman Kodak Firestone • Ford • General Motors • Goodrich • Gulf Oil • Hercules Powder • Jones & Laughlin Steel • Norton Company • Owens-Illinois • Republic Steel • Shell Oil •* SKF *• Socony Vacuum • Studebaker • Texas Company • U. S. Army • U. S. Navy.*

Engineering and Manufacturing
Information Essential to . .

NATIONAL DEFENSE

THE TOOLS FOR DEFENSE

THE United States is producing spectacular numbers of tanks, planes and battleships made with a staggering number of direct and indirect tools. The tools used directly are the machines which make the parts; just as vital, even though less obvious, are the indirect means of manufacturing. These include the buildings which must be built to house the machines, the mechanical and electrical equipment of the structures themselves, and the technical press which disseminates technical information on these subjects to those whose task it is to design, construct and operate such buildings.

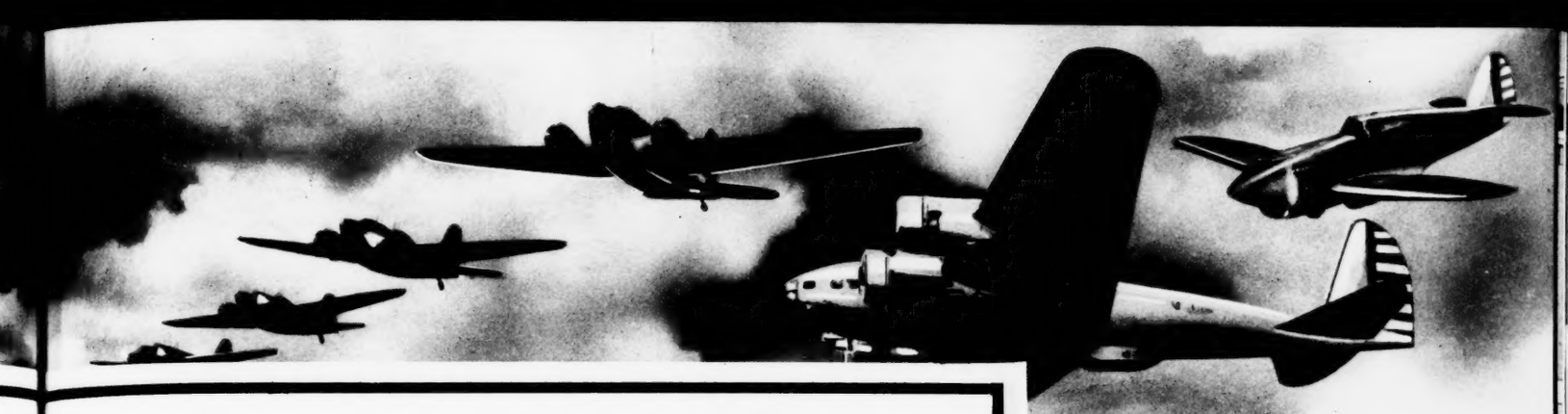
Among these indirect tools for defense, then, are heating, ventilating and air conditioning equipments, the development of which, together with the techniques and methods of applying them, are the subjects with which HEATING AND VENTILATING and similar business papers are concerned.

EVERY PLANT A DEFENSE PLANT

Control of air conditions, whether that of the temperature, cleanliness or moisture content, is today exemplified in every conceivable type of plant. And it must be emphasized that every type of plant is involved in National Defense. Metal-working plants must make the tanks, planes and ships; pharmaceutical plants must supply serums, vaccines, drugs; the food industries must function to feed the workers as well as the army; textile mills are busy making uniforms, tents, powder bags; rubber plants supply the tires on which innumerable trucks and tractors roll; tanning factories turn out shoes on which the army tramps; munitions plants have sprung up like mushrooms to supply the powder.

AIR CONDITIONING AN AID TO PRODUCTION

In every one of these air conditioning has been applied to fur-



ther the process in one way or another—controlling expansion of metal gages, moisture content of drugs; cooling bread, maintaining humidity in cotton mills, cleaning air where precise tools are used, and so on. Further, heat is necessary in practically all cases if only to prevent stiff and freezing fingers; ventilation is almost universal where toxic fumes and harmful dusts are present later to damage workers' lungs.

So heating or ventilating or air conditioning systems speed production, cut production costs, increase workers' efficiency and protect their health in the plants engaged directly or indirectly in defense.

IMPORTANCE OF INTERCHANGE OF IDEAS

But the equipment and techniques which make these systems possible were not developed overnight. They are the result of years of work and ingenuity and interchange of ideas. The designer of a windowless air conditioned plant is working with the accumulated skill and experience of thousands of other similar designers whose ideas, methods, formulas and data are exchanged through the pages of the technical press.

That the application of these ideas, equipments and methods would be concentrated on industrial plants became apparent in the summer of 1939 (before the war began) when HEATING AND VENTILATING began work on its Profits in Air section, devoted exclusively to manufacturing processes. The war had hardly started when in this section was described the use of air conditioning to control moisture in blast furnace operation—a process which increases iron or steel production and reduces cost, and is now under consideration in at least a dozen plants. Dehumidification in a biological plant producing serums was covered, as was the exhaust ventilation of a motor company tool room.

[*Concluded on Next Page*